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PILOT'S HANDBOOK

MODEL XPBB-1

MANUFACTURED BY THE

BOEING AIRCRAFT COMPANY

FOR THE

UNITED STATES NAVY

UNDER

CONTRACT NXsa 16848

BOEING AIRCRAFT COMPANY
SEATTLE, WASHINGTON

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SECTION I

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FOREWORD

This handbook has been prepared for the purpose of acquainting the U. S. Navy flight personnel with the principal operational features of the XPBB-1 airplane. The operational duties are divided among several members of the flight crew; therefore, it is necessary that each member be familiar with and understand the duties of every other member so that their efforts may be coordinated to provide the safest and most economical operation. For further study, reference is made to the "Handbook of Erection and Maintenance Instructions" furnished with this airplane, together with the instruction manuals on equipment therein referred to.

These instructions are subject to revision as necessary after completion of tests and delivery of the airplane.

BOEING AIRCRAFT COMPANY
Seattle, Washington
February, 1943

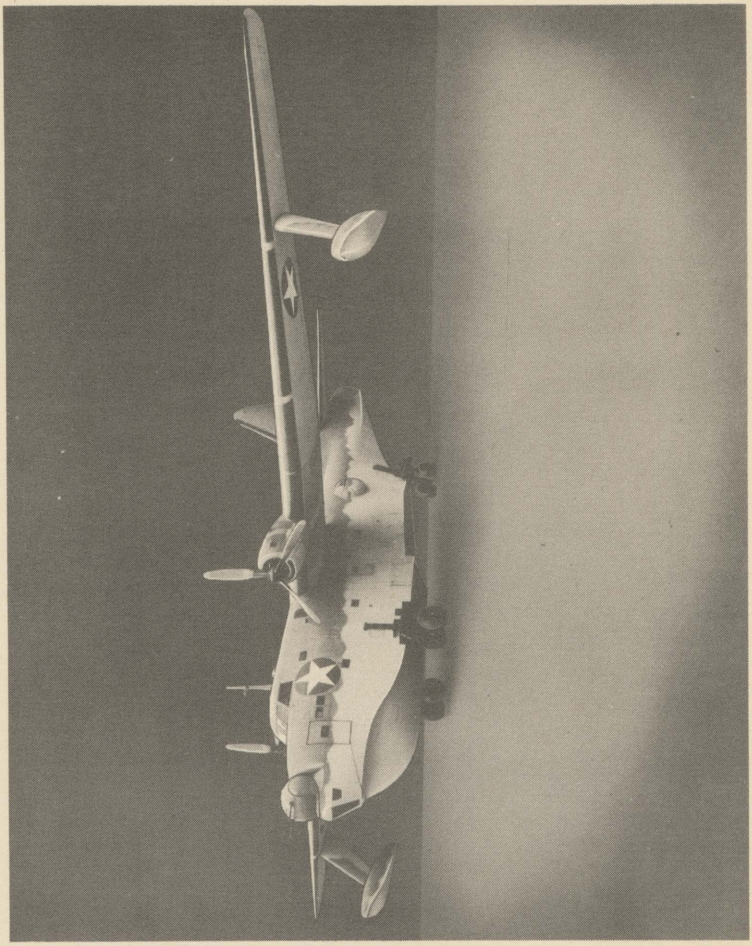

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FIG. I COMPLETE AIRPLANE

Section III
GENERAL DESCRIPTION

1. AIRPLANE

a. GENERAL—See Figures 1 and 2.

The model XPBB-1 airplane is a full cantilever, high wing flying boat powered with two engines and designed for use as a patrol bomber or torpedo airplane, operating from the water or from a special catapult.

The airplane is provided with beaching gear consisting of three trucks; right and left front trucks and one rear truck. Each truck has two wheels with pneumatic tires. The beaching gear is easily attached or detached from the hull with keyhole type fittings which require a quarter turn of the key to secure or remove the fitting.

Fittings are provided on the hull to receive removable trunnions by which the airplane is handled on the handling car and launching car when it is to be flown in the assisted takeoff condition.

The airplane structure is substantially of Alclad aluminum alloy construction.

The over-all dimensions are as follows: Over-all span—139 ft. 8 in., hull length (without guns)—94 ft. 9 in., height, keel to tip of fin—35 ft. The draft at the lowest part of the hull at maximum weight, in non-assisted takeoff condition is 3 ft. 10.4 in.

b. WING

The wing consists of three sections: The center section and two outboard panels. The center section includes the two engine nacelles and integral bomb bays and fuel and oil tanks. Each outboard panel includes an integral main fuel tank and outboard auxiliary fuel tank and an auxiliary fixed float attached at Station 590. The inboard wing flaps are on the wing center section; outboard flaps are on the outboard panels.

c. TAIL

The tail group consists of a stabilizer, elevator, fin and rudder, with trim tabs for both elevator and rudder.

d. HULL

The hull is divided into seven water-tight compartments on the lower decks and one compartment on the upper or control deck. Doors are provided in each bulkhead to provide a passage from nose to tail. Bulkhead doors may be dogged down on a pressure seal to make them watertight. Dogs are operable from either side. A hatch in the deck of the control cabin and a ladder below provide access to the control cabin from the lower deck. See Figure 3 for a study of possible avenues of escape in emergency.

MAXIMUM HEIGHT OF AIRPLANE ON BEACHING GEAR, TIRES UNDER LOAD OF 1 W. (DIMENSION FROM TOP OF FIN)—34'-1.80".

CLEARANCE OF KEEL OVER GROUND - 1'-8.25"

CLEARANCE OF KEEL OVER TOP OF 10:1 RAMP - 9.25"

NORMAL INCIDENCE OF STABILIZER - 0°

ADJUSTMENT OF STABILIZER EACH SIDE OF NORMAL POSITION - PLUS 3° OR MINUS 3°

GROSS DISPLACEMENT OF AUX. FLOAT IN LBS. OF SEA WATER - 5504 LBS.

ANGLE BETWEEN PERPENDICULAR & LINE PASSING FROM AXLE OF BEACHING GEAR TO THE CENTER OF GRAVITY AT DESIGN GROSS WEIGHT—41° 18'

ANGLE BETWEEN BASE LINE & HORIZONTAL WHEN AIRPLANE IS ON BEACHING GEAR - 3.10°

ANGULAR MOVEMENT OF ALL CONTROL SURFACES:

AILERON —18° ± 1° UP OR DOWN — TAB—24° ± 1° UP OR DOWN
ELEVATOR—25° ± 2° UP, 15° ± 2° DOWN — TAB— 6° ± 2° UP OR DOWN
RUDDER —23° ± 2° R. OR L. — TAB— 11° ± 2° R. OR L.
WING FLAP —45° DOWN

AREAS:	SQ. FT.	
WINGS (INCL. AILERONS)	1826.40	
AILERONS (AFT OF HINGE ℄)	95.70	
FLAP	312.00	
HORIZ. STABILIZER	253.76	GROSS
ELEVATOR (AFT OF HINGE ℄)	79.40	
TOTAL HORIZONTAL TAIL	333.16	
FIN	229.40	GROSS
RUDDER (AFT OF HINGE ℄)	37.60	
TOTAL VERTICAL TAIL	267.00	

AIRFOIL SECTION - BAC 117 23%-9%

POWER PLANT - WRIGHT R-3350-8

AIRFOIL SECTION FOR WING IS BAC 117 - FOR TAIL SURFACE SEE DOCUMENT D-2727

MAXIMUM DRAFT FOR THIS AIRPLANE - 3'-10.40"

MINIMUM DEPTH FOR ATTACHMENT OF BEACHING GEAR - 6'-3"

ANGLE OF LIST TO SUBMERGE AUXILIARY FLOAT. - 7.3°

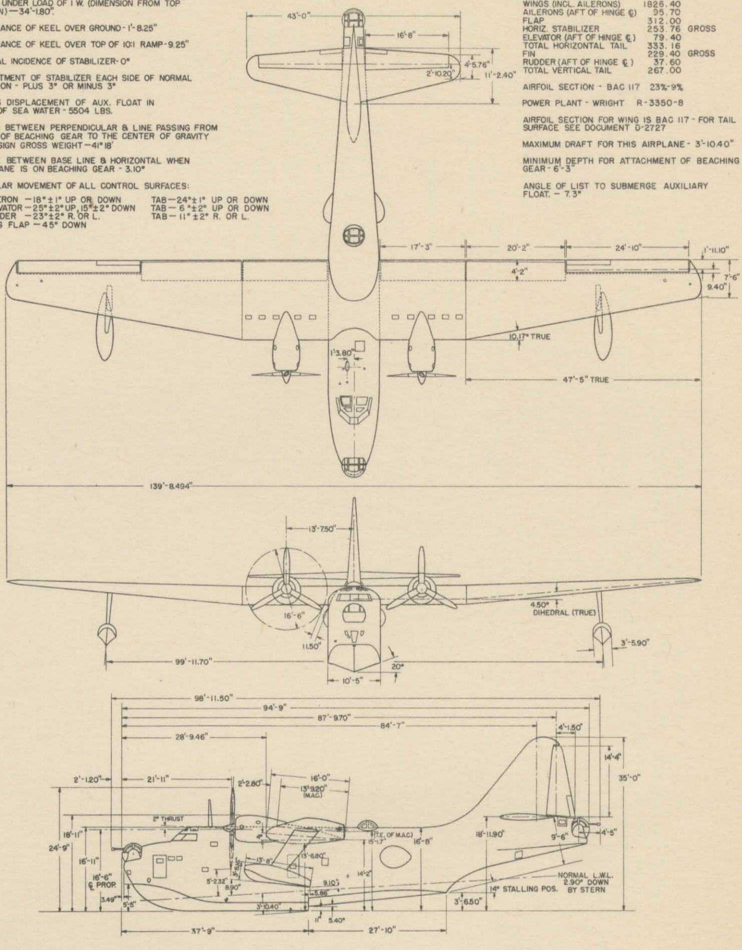

FIG. 2 GENERAL ARRANGEMENT 15-6577

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2. EQUIPMENT

a. FIRE EXTINGUISHERS

A fixed carbon dioxide fire extinguisher system is provided for each nacelle. The supply for this system is one 12.5 pound cylinder of CO_2, adjustable to either nacelle by the controls at the engineer's station. The auxiliary power plant is provided with a fixed fire extinguisher system with automatic and manual releases. Its supply is one 5 pound CO_2 cylinder in the bow compartment on bulkhead 150. Other small portable fire extinguishers are provided in the bow compartment, the control cabin, the galley and the crew's quarters.

b. DEICER EQUIPMENT

The noses of the wing, stabilizer and fin are covered with a sectioned, inflatable rubber shoe for deicing purposes. Two air pumps on the left-hand engine and two on the right-hand engine furnish pressure and vacuum to inflate and deflate the deicer shoes. The systm consists of a large pressure line and a smaller suction line running spanwise in the wing. Only a pressure line leads to the tail deicer shoes. Individual soelnoid-operated valves are installed in these lines near each set of deicer shoe connections. The valves are controlled by a central electric timer and provide quick action inflation of the shoes. The entire system is controlled by a single switch on the engineer's panel.

The propeller anti-icer system has a 15 gallon tank for anti-icer fluid installed in the galley compartment. An electric pump with two outlets is mounted immediately below the supply tank and pumps the fluid through the system to the slinger ring on each propeller. The pump is controlled by a rheostat at the engineer's station.

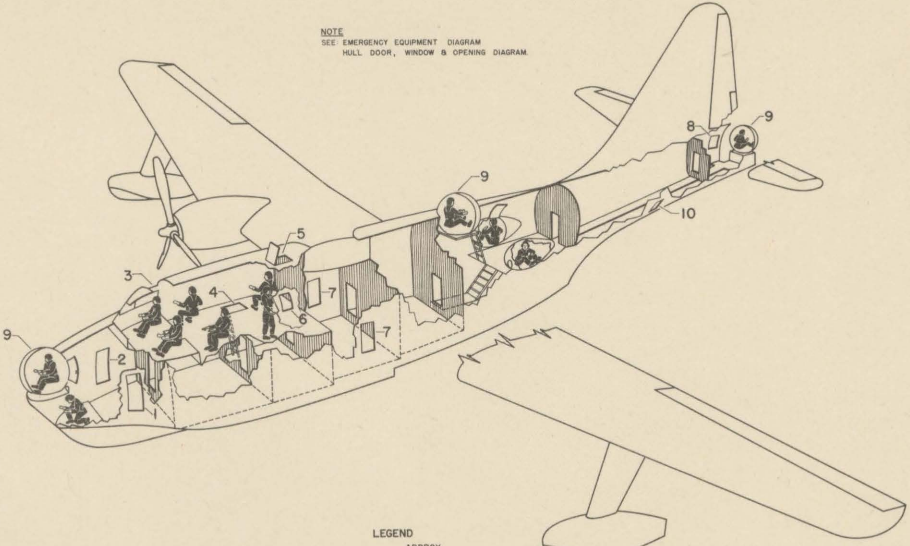
c. HEATING AND VENTILATING

The cabin heating and ventilating system consists of a Stewart-Warner combustion heater and ventilating blower with control at the engineer's station and with the necessary ducts and duct valve controls. Fuel is 100 octane gasoline taken from the cross-supply line. Cabin temperature is thermostatically controlled.

d. ARMAMENT

The airplane is equipped with ten bomb bays in the wing center section, five on either side of the hull. Bomb bay doors are sheet aluminum panels which slide in tracks along either side of the bomb bay. Doors are normally power operated by an electric motor controlled by either the pilot or the bomber. Provisions are also made for manual operation.

NOTE
SEE: EMERGENCY EQUIPMENT DIAGRAM
HULL DOOR, WINDOW & OPENING DIAGRAM.



LEGEND

EXIT	LOCATION	APPROX. OPENING SIZE	OPERATION OF UNIT
1- PORT BOW MOORING DOOR	L.H. ONLY	33 X 54	RELEASE DOGS - TURN HANDLE - SWING IN
2- STARBOARD BOW MOORING DOOR	R.H. ONLY	24.8 X 48.2	RELEASE DOGS - TURN HANDLE - SWING IN
3- CO-PILOT'S HATCH	TOP RIGHT FWD.	22 X 26.7	RELEASE DOGS - TURN HANDLE - SWING UP
4- FLIGHT DECK HATCH	F.D. FLOOR R.H. ONLY	26 X 34.4	TURN HANDLE - SWING UP
5- NAVIGATOR'S HATCH	TOP LEFT CENTER	22.5 X 26.2	PULL PINS - SWING UP
6- NAVIGATOR'S WINDOW	R.H. ONLY	19.8 X 24.2	REMOVE SEAL - PULL IN
7- MAIN ENTRY DOORS	R.H. & L.H.	25 X 49.7	RELEASE DOGS - TURN HANDLE - SWING IN
8- EMPENNAGE ACCESS HATCHES	R.H. & L.H.	25.7 X 28.7	RELEASE DOGS - PULL IN
9- SPHERICAL TURRET CANOPIES	——	——	RELEASE DOGS - PUSH OUT
10- AFT. MOORING HATCH	L.H. ONLY	19 X 16.7	RELEASE DOGS - SWING UP

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FIG. 3 EMERGENCY EXITS DIAGRAM

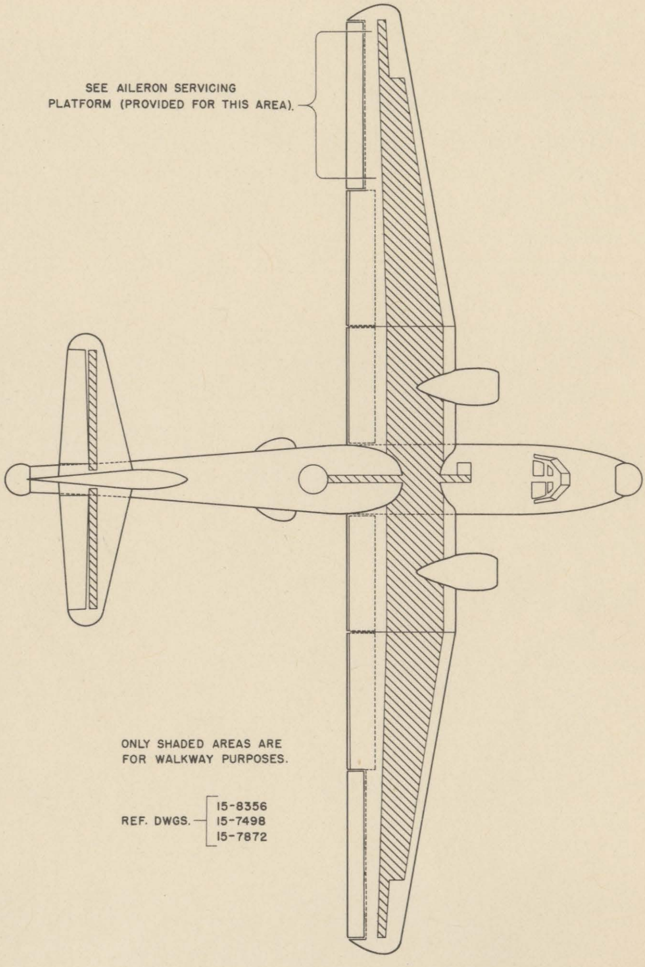

FIG. 4 WALKWAY AREA DIAGRAM

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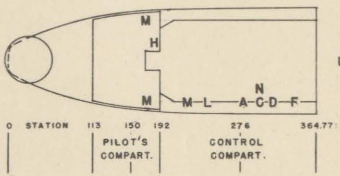
FIG. 5 EMERGENCY EQUIPMENT DIAGRAM

EMERGENCY EQUIPMENT

	EQUIPMENT	SIZE & CAPACITY	NO. REQ.	MFR. OR REFERENCE	BAC. NO.
A	FIRE EXTINGUISHER, PORTABLE	2 LBS.	3	WALTER KIDDE & CO.	3-12843
B	FIRE EXTINGUISHER, PORTABLE	5 LBS.	1	WALTER KIDDE & CO.	3-12843-2
C	LIFE RAFT	7 MEN	1	GOODYEAR CO.	1-17281
D	LIFE RAFT	4 MEN	1	GOODYEAR CO.	1-17281-1

GOV. FURN. & INST. SUPPORTS BY B.A.C.

	EQUIPMENT	SIZE & CAPACITY	NO. REQ.	MFR. OR REFERENCE	BAC. NO.
E	FIRST AID KIT	———	1	———	6-10380-4
F	WATER	13.5 GALS. AT 4.5 GALS. EA.	3 STD.	———	8-2158
G	FLARES, PARACHUTE	———	8	———	14-2971
H	VERY PISTOL & AMMUNITION	———	1	———	9-5373
J	GRENADES, SMOKE	———	4	———	15-9914
K	LIGHTS, FLOAT	———	40	———	15-9395
L	PISTOL, PYROTECHNIC & AMM.	———	1	———	15-9372
M	PARACHUTES	———	16	———	15-7717 15-7718
N	FOOD RATIONS	100 LBS. AT 10 LBS. / MAN	10	———	14-2941



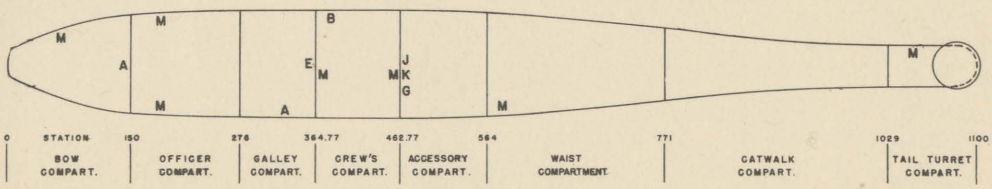
UPPER DECK PLAN

REF. DRAWINGS:
15-7717 - EQUIPMENT INST. - FLIGHT DECK
15-7718 - EQUIPMENT INST. - LOWER DECK

NOTE

EMERGENCY CONTROLS SHOWN ON "MANUAL CONTROL LOCATION DIAGRAM" - ITEMS 6, 20, 21, 22, 23.

GENERAL EQUIPMENT SHOWN ON "EQUIPMENT DIAGRAMS" - SHEETS 1, 2, 3.



LOWER DECK PLAN

Gunnery equipment consists of five Erco power operated turrets; one in the nose, one in the tail, one in the top waist at station 596 and one in each side waist at station 666.

Provision has been made below the inboard bomb bays for carrying two Mark XV torpedoes, or as alternate loads, two Mark XIII, or two Mark XIII—Modification 1 torpedoes. Torpedo release is electric and controlled by the pilot but in emergency, torpedoes may be released by the mechanical emergency bomb release system.

e. COMMUNICATIONS

(1) INTERPHONE

The airplane is equipped with a Type RL-24B interphone set serving fifteen stations. This equipment provides communication between all gunners and flight crew stations and a station each in the officers' and crew's quarters.

(2) RADIO

The intra-squadron radio equipment consists of a Type GF-9 transmitter and a RU-14 receiver with controls at the pilots' station. Other radio equipment includes a GO-5 transmitter, two RU-12 receivers and a Model DZ-1 direction finding receiver, all installed at the radioman's station on the right-hand side of the control cabin behind the copilot.

f. EMERGENCY EQUIPMENT—See Figure 5

Two pneumatic life rafts, one Navy Type Mark IV and one Navy Type Mark VII, are strapped to their supports on the wall under the navigator's table.

Three portable carbon dioxide fire extinguishers are mounted on wall brackets: One in the control cabin, one in the galley and one in the crew compartment. A canvas sea anchor is stowed in the waist compartment. Lines for handling the anchor are carried on the left-hand sidewall in the bow compartment.

Supports are installed for the following Government furnished equipment:

(1) A first aid kit on bulkhead 364 in the galley.

(2) Float lights and smoke grenades on Bulkhead 462 in the accessory compartment.

(3) Eight parachute flares on the aft side of Bulkhead 462. Two release tubes are installed in the port sidewall of the accessory compartment.

(4) A Very pistol and ammunition on deck 137 to the right of the copilot, and a pyrotechnic pistol and ammunition on the sidewall to the left of the commander's seat.

Section IV
CONTROLS

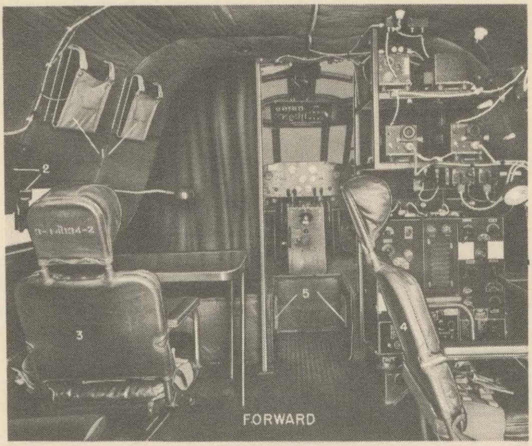
1. LIST OF CONTROLS

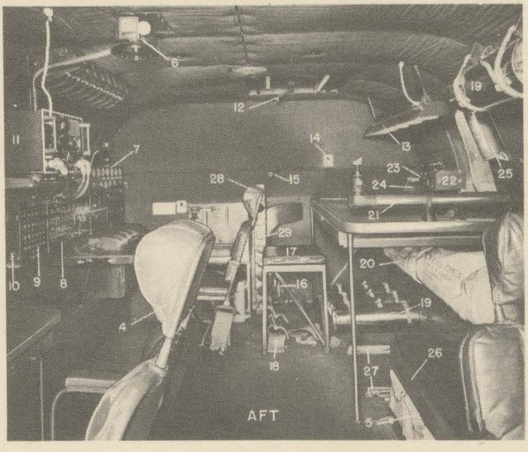
a. FLYING CONTROLS

Control	*Type*	*Location*
Aileron	Wheel (2)	Column in front of pilots
Elevator	Column (2)	In front of pilots
Rudder	Pedals (4)	In front of pilots
Trim Tabs		
Aileron	Wheel	Pilots' Control Stand
Elevator	Wheel	Pilots' Control Stand
Rudder	Wheel	Pilots' Control Stand
Wing Flaps	Switch	Pilots' Control Stand
Throttle & Surface Lock	Lever	Pilots' Control Stand
A.F.C.E.	Switches	Pilots' Control Stand & Bomber's Panel

b. POWER PLANT AND FUEL SYSTEM CONTROLS

Ignition	Switch (4)	Two on Pilots' Panel & two on Engineer's Panel
Throttle	Lever (6)	Four on Pilots' Control Stand & two on Engineer's Control Stand
Mixture	Lever (2)	Engineer's Control Stand
Carburetor Air	Lever (2)	Engineer's Control Stand
Supercharger	Lever (2)	Engineer's Control Stand
Throttle Brake	Lever	Pilot's Control Stand
Propeller Controls		
Propeller Pitch	Knob (2)	One on Engineer's Cont. Stand & one on Pilots' Control Stand
Propeller Master Unit	Switch	Engineer's Switch Panel
Circuit Breakers	Push Button (2)	Engineer's Switch Panel
Feathering Switches	Switch (2)	Engineer's Switch Panel
Selector Switches	Switch (2)	Engineer's Switch Panel





1. PARACHUTE HOLDER
2. PYROTECHNIC PROJECTOR AND AMMUNITION BOX
3. COMMANDER'S CHAIR
4. RADIO OPER. CHAIR
5. PILOT'S HANDBOOK STOWAGE
6. LOOP ANTENNA CONTROL
7. ENGR'S. INSTR. PANEL
8. ENGR'S. SWITCH PANEL
9. CIRC. BREAKER PANEL
10. COMPT. LIGHT SWITCH
11. D.F. RECEIVER
12. NAVIGATOR'S HATCH OPERATING CRANK
13. NAV. TABLE LIGHT
14. INTERPHONE BOX
15. BOMB DOOR CRANK ATTACH.
16. BOMB DOOR CRANK
17. NAVIGATOR'S PLATFORM
18. NAV. SAFETY BELT
19. WATER BREAKERS
20. LIFE RAFTS
21. DRIFT SIGHT
22. COMPASS
23. NAV. INSTRUMENTS
24. BOOK RACK
25. FIRE EXT.
26. TRANSOM
27. STOWAGE STRAPS - EMERG. FOOD CONT.
28. ENGINEER'S CHAIR
29. CANISTER RACK

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FIG. 6 FLIGHT DECK

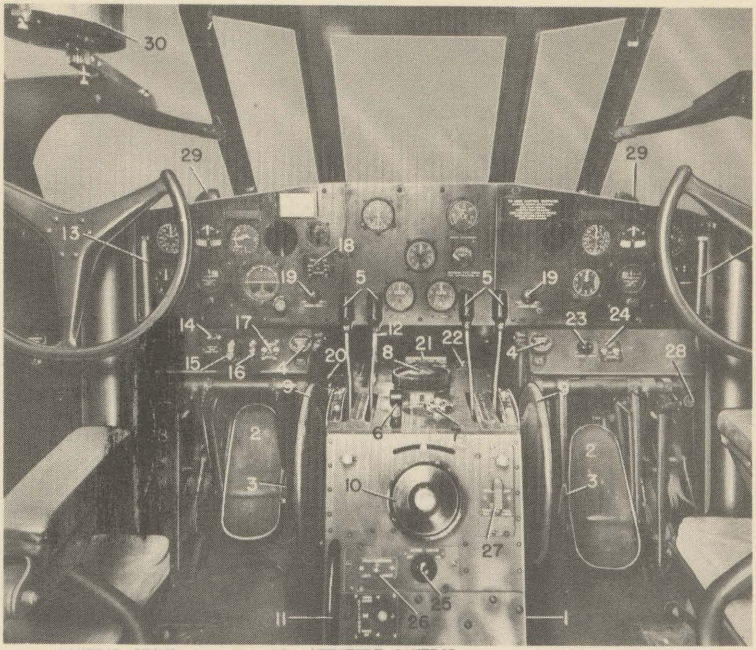
Control	*Type*	*Location*
Starter	Switch (2)	Engineer's Switch Panel
Booster Cutout	Switch (2)	Engineer's Switch Panel
Primer	Switch (2)	Engineer's Switch Panel
Cowl Flaps	Switch (2)	Engineer's Switch Panel
Oil Cooler Door	Switch (2)	Engineer's Switch Panel
Oil Transfer Pump	Switch (2)	Engineer's Switch Panel
Fuel Tank Selector Valve	Knob (2)	Bulkhead 364
Auxiliary Fuel Pump	Switch (2)	Engineer's Switch Panel
Strainer Drain	Switch (2)	Engineer's Switch Panel

c. ELECTRICAL CONTROLS

A.C. Inverter	C.B. Switch	Engineer's Switch Panel
D.C. Instruments	C.B. Switch (2)	Engineer's Switch Panel
Pitot Heaters	Switch (2)	Copilot's Switch Panel
Landing Lights	Switch (2)	Pilot's Switch Panel
Section Lights	Switch (2)	Pilot's Switch Panel
Anchor Lights	Switch (2)	Pilots' Switch Panel & Hull Skin Aft of Port Entrance Door
Running Lights	Switch (2)	Pilots' Switch Panel
Formation Lights	Switch (2)	Pilots' Switch Panel
Recognition Lights	Switch (4)	Pilots' Switch Panel
Fluorescent Instr. Lights	Switch (3)	Pilots' Switch Panel
Instrument Panel Lights	Switches	See Text
Circuit Breakers	Push Button & Switch Type	See Illustration
Alarm Horn—Fog Horn	Switch (2)	Pilots' Switch Panel & Commander's Station

d. ARMAMENT CONTROLS

Bomb Doors	Switches (2)	Pilot's Switch Panel Bomber's Switch Panel
Emerg. Bomb Door Opening	Switches (2)	Pilot's Switch Panel Bomber's Switch Panel



1. CONTROL STAND
2. RUDDER PEDALS
3. RUDDER PEDAL ADJUST.
4. RUDDER PEDAL TILT
5. THROTTLE CONTROLS
6. THROTTLE BRAKE
7. PROP. PITCH CONTROL
8. RUDDER TAB CONTROL
9. ELEVATOR TAB CONTROL
10. AILERON TAB CONTROL
11. ATTITUDE CONTROL
12. SURFACE LOCK
13. FLUORESCENT LIGHT
14. BOMB DOOR IND. LIGHT
15. BOMB DOOR CONTROL SW.
16. BOMB-TORPEDO SEL. SW.
17. TORPEDO SEL. SWITCHES
18. IGNITION SWITCHES
19. RHEO.-COMPASS LIGHTS
20. FIRING KEY
21. A.F.C.E. SWITCHES
22. P.D.I. & TELLTALE LIGHT SWITCH
23. RHEO-STANDBY LIGHTS
24. PITOT HEATER SWITCHES
25. RHEO.-STAND LIGHTS
26. PRECESSING SWITCH
27. FLAP CONTROL SWITCH
28. STOP-CONTROL COLUMN
29. WINDSHIELD HEAT DUCT
30. TORPEDO DIRECTOR

30164 FIG. 7 PILOTS' INSTRUMENTS AND CONTROLS (SHEET 1)

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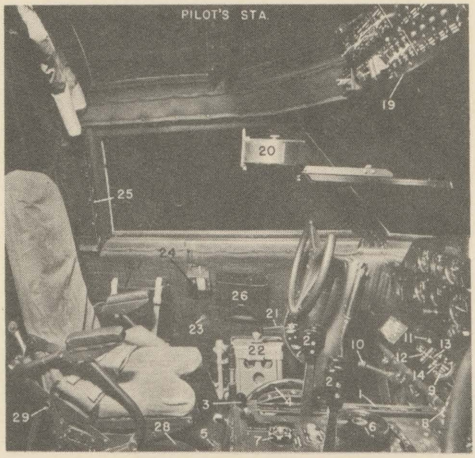
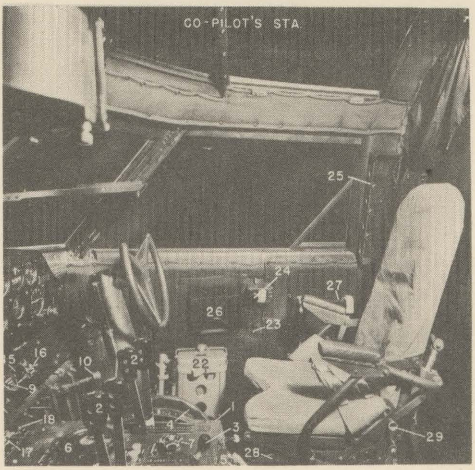
Control	*Type*	*Location*
Bomb Door Spoiler Flaps	Switch	Bomber's Switch Panel
Bomb Release	Levers	Sidewalls at left of Pilot and Bomber
Bomb Torpedo	Switch	Pilot's Switch Panel
Torpedo Selector	Switches (2)	Pilot's Switch Panel

e. EQUIPMENT CONTROLS

Seat Adjustment	Levers	Edge of Each Seat
Towing & Mooring Fittings		See Text and Illustration
Auxiliary Power Plant		
Starter	Switch	Engineer's Switch Panel
Ignition	Switch	Engineer's Switch Panel
Oil Heater	Switch	Engineer's Switch Panel
Fuel Selector Valve	Handle	Bulkhead 364
Generator	Switch	Engineer's Switch Panel
Fire Extinguisher	Handle	Bulkhead 150 (rear side)
Instrument Vacuum Valve	Handle	Bulkhead 364
Surface De-icer	Switch	Engineer's Switch Panel
Propeller Anti-icer Rheostat	Knob	Engineer's Switch Panel
Cabin Heater Control	Switch	Engineer's Switch Panel
Cabin Heater Duct Controls	Levers	See Text
Windshield Heater Control	Switch (3)	Engineer's Switch Panel; Pilots' Switch & Circuit Breaker Panel; Bomber's Switch Panel
Fuel Dump Valves	Lever (4)	Bulkhead 364
Engine Fire Extinguishers	Selector Valve & Pull Handle	Bulkhead 364





1. CONTROL STAND
2. THROTTLE CONTROLS
3. THROTTLE BRAKE
4. ELEVATOR TAB CONTROL
5. AILERON TAB CONTROL
6. RUDDER TAB CONTROL
7. PROPELLER PITCH CONTROL
8. SURFACE LOCK
9. RUDDER PEDAL TILT
10. CONTROL COLUMN STOP
11. BOMB DOOR INDICATOR LIGHT
12. BOMB DOOR CONTROL SWITCH
13. BOMB-TORPEDO SELECTOR SWITCH
14. TORPEDO SELECTOR SWITCH
15. RHEOSTAT - STANDBY LIGHTS
16. PITOT HEATER SWITCHES
17. A.F.C.E. SWITCHES
18. P.D.I. & TELLTALE LIGHT SWITCH
19. SWITCH & CIRCUIT BREAKER PANEL
20. TORPEDO DIRECTOR
21. BOMB RELEASE CONTROL
22. REBREATHER
23. OXYGEN OUTLET
24. INTERPHONE BOX
25. CANISTER RACK
26. REPORT HOLDER
27. PARACHUTE HOLDER
28. CHAIR ADJUST. - VERTICAL
29. CHAIR ADJUST. - ANGULAR

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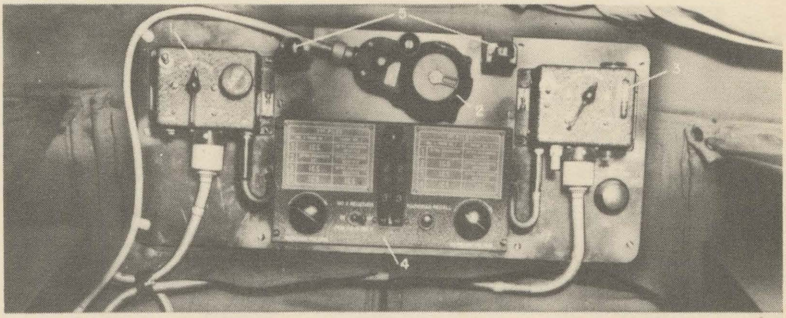
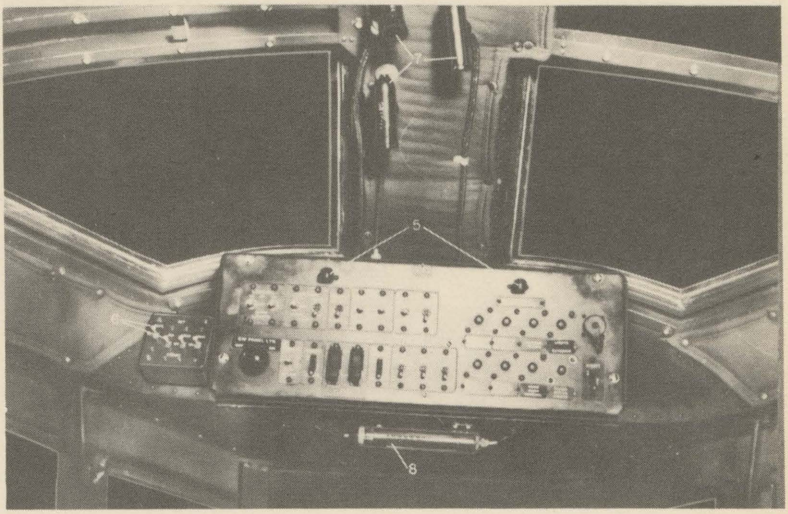
FIG. 8 PILOTS' INSTRUMENTS & CONTROLS

(SHEET 2)

Control	*Type*	*Location*
Vapor Dilution System	Handle (2)	Bulkhead 364
Flare Release	Switch (2)	Pilots' Switch Panel
Emergency Cut-Off	Switch	Above Engineer's Switch Panel
Refrigerator	Switch	Galley
Hotplate	Switch	Galley





1-RECEIVER CONTROL
2-RECEIVER TUNING CONTROL
3-TRANSMITTER CONTROL
4-INTERPHONE CONTROL
5-PANEL LIGHTS
6-RECOGNITION LIGHT SWITCHES
7-STANDBY LIGHTS
8-FLUORESCENT LIGHT

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FIG. 9 PILOTS' INSTRUMENTS & CONTROLS
(SHEET 3)

2. OPERATION OF CONTROLS

a. GENERAL

Flight controls are conventional. A stand between the pilots carries A.F.C.E. switches, trim tab and attitude controls, propeller speed (pitch) control and throttle controls. Auxiliary ignition switches are mounted on the pilot's instrument panel. All other engine controls are located at the engineer's station.

b. FLIGHT CONTROLS

The flight controls are conventional dual wheel, column and stirrup arrangement. Control surfaces are operated directly by cable systems. Rudder and elevator locks consist of quadrants attached to the torque tubes and engaged by controlled locking pins. The aileron lock pin engages the aileron cable control drum on the rear spar bulkhead. An interconnected cable system with a control lever on the pilots' control stand operates all locking pins at the same time.

Wing flaps are power operated by two reversible electric motors, one for inboard flaps and one for outboard flaps. Both motors are controlled at the same time by a single switch on the pilots' control stand.

(1) AILERON

Control of the aileron is provided from either pilots' wheel by direct drive through a cable system. Full travel of the aileron is 18° up or 18° down. For full travel of the aileron, the control wheel rotates 242° either side of neutral (no load). Aileron travel is limited by stops in the control column.

(2) RUDDER

Control of the rudder is provided from either pair of pedals by direct drive through a cable system. Each pedal is separately adjustable three inches fore and aft in one-half inch increments by means of spring-loaded locking pins in the side of the quadrant. The tilt of each pedal is adjustable by a knob on the panel above the pedals. Maximum rudder travel is 23° left and 23° right, equivalent to pedal movement of 5 inches forward and 5 inches aft of neutral. Rudder travel is limited by stops on the rudder lock quadrant.

(3) ELEVATORS

The elevator is controlled from either control column by direct drive from a quadrant and cable system. Stops at the elevator lock quadrant determine the limits of travel: up 25°, down 15°. Adjustable stops are provided to limit control column movement.

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LEGEND

FLIGHT CONTROLS

1. CONTROL COLUMN
2. RUDDER PEDALS
3. RUDDER TAB] PILOTS' CONTROL STAND
4. ELEVATOR TAB] PILOTS' CONTROL STAND
5. AILERON TAB] PILOTS' CONTROL STAND
6. ATTITUDE] PILOTS' CONTROL STAND
7. SURFACE LOCK] PILOTS' CONTROL STAND
8. EMERGENCY WING FLAP

ENGINE CONTROLS

9. PROP. PITCH
10. SUPERCHARGER
11. THROTTLE
12. MIXTURE
13. CARBURETOR AIR
14. THROTTLE BRAKE

FUEL CONTROLS

15. TANK SELECTOR VALVES
16. AUX. P. P. TANK SEL. VALVE
17. FUEL DUMP VALVES

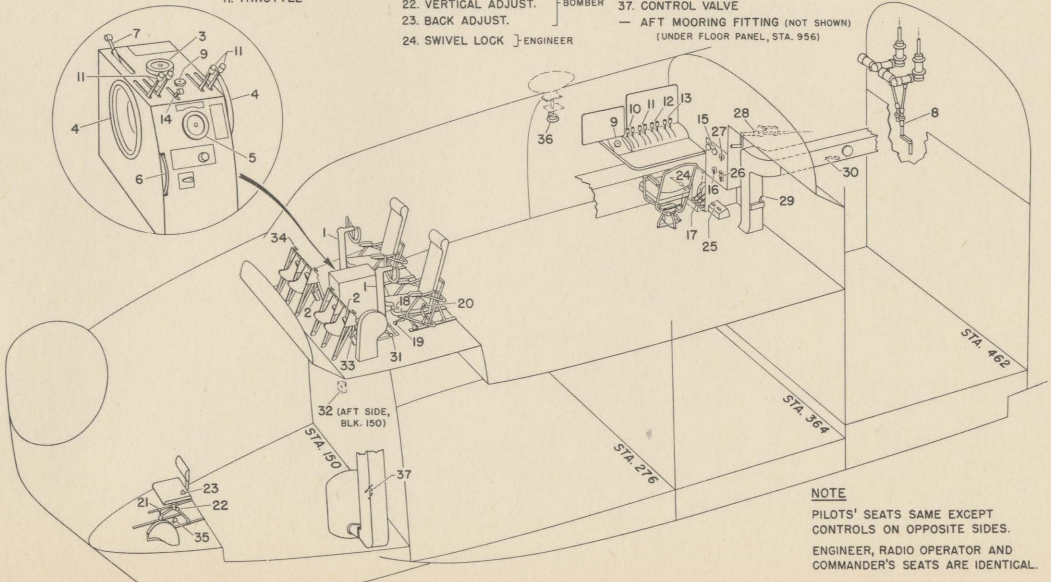
SEAT CONTROLS

18. HORIZONTAL ADJUST.] PILOT
19. VERTICAL ADJUST.] PILOT
20. ANGULAR ADJUST.] PILOT
21. HORIZONTAL ADJUST.] BOMBER
22. VERTICAL ADJUST.] BOMBER
23. BACK ADJUST.] BOMBER
24. SWIVEL LOCK } ENGINEER

OTHER CONTROLS

25. VAPOR DILUTION
26. FIRE EXTINGUISHER (ENGINE)
27. INSTRUMENT VACUUM
28. EMERGENCY BOMB DOOR
29. CABIN VENTILATOR
30. ENGINE WARM-UP DUCT VALVE
31. EMERG. BOMB RELEASE (PILOT'S)
32. AUX. P. P. FIRE EXTINGUISHER
33. RUDDER PEDAL ADJUST.
34. RUDDER PEDAL TILT
35. EMERG. BOMB RELEASE (BOMBER'S)
36. LOOP ANTENNA
37. CONTROL VALVE

— AFT MOORING FITTING (NOT SHOWN) (UNDER FLOOR PANEL, STA. 956)



NOTE

PILOTS' SEATS SAME EXCEPT CONTROLS ON OPPOSITE SIDES.

ENGINEER, RADIO OPERATOR AND COMMANDER'S SEATS ARE IDENTICAL.

FIG. 10 MANUAL CONTROL LOCATIONS DIAGRAM

(4) TRIM TABS

The aileron trim tabs, one in each aileron, are controlled from a wheel on the rear face of the control stand. A connecting cable system drives a non-reversible tab operating screw in each aileron. The position indicator is located above the control wheel.

The rudder tab is controlled by a wheel on top of the control stand. A connecting cable system drives a non-reversible tab operating screw in the rudder. A position indicator is located under the control wheel.

The elevator trim tabs are controlled together by wheels on either side of the control stand. A connecting cable system drives non-reversible screws in each elevator. A position indicator is located at the inboard side of each wheel.

Adjustable friction brakes are provided on all trim tab cables to prevent cables from "creeping". Brakes are located in the left-hand cable tunnel forward of Bulkhead 364.

(5) WING FLAPS

Inboard and outboard flaps have separate cable systems and electric motors for their operation. A single control switch on the rear face of the control stand controls both motor relays, thus making all flaps controllable from one switch. The control switch and limit switch adjustments provide for three flap positions: UP, DOWN (45°), and TAKEOFF (30°). When the control switch is adjusted to one of these positions the flaps will stop in that position except that flaps will not move from the DOWN position to the TAKEOFF position directly but must first be adjusted to some position above TAKEOFF by adjusting the switch to UP. The flaps will extend to the full down position in 15 to 25 seconds and will retract from the full down position in 20 to 30 seconds. A dual indicator on the pilots' panel indicates the position of both the inboard and outboard flaps. The crank attachment fittings for operating the flaps by hand are located aft of and above the door in Bulkhead 462. A ratchet in the torque shaft above the crank attachment permits the crank to be turned part of a revolution at a time and prevents reverse motion under heavy flap load. The crank is stowed on the rear of Bulkhead 462 on the R.H. side of the door.

(6) SURFACE LOCKS

Control surfaces are locked or unlocked by the operation of the surface lock lever on the control stand. The lever operates a drum and cable system which inserts locking pins in notches in quadrants on the elevator and rudder torque tubes. The aileron locking pin engages a

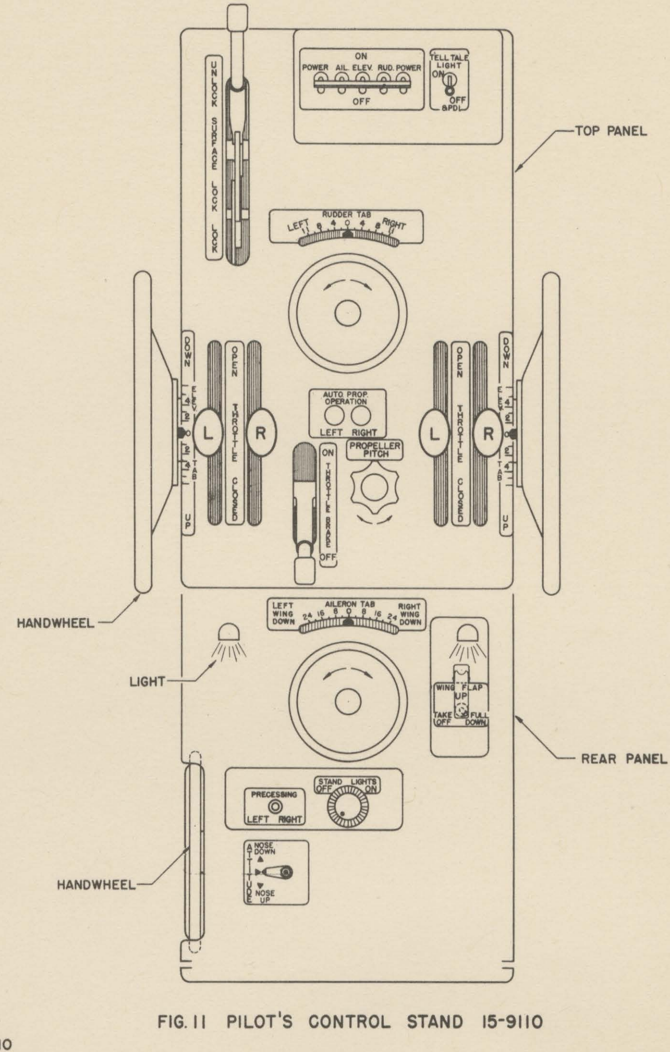


FIG. 11 PILOT'S CONTROL STAND 15-9110

slot in the control drum at the rear spar. The control surface lock lever also locks the throttle. To lock the surfaces the throttle must be closed. With all control surfaces in neutral position, pull the lever back to the LOCK position, and try each of the controls to be certain that the locking pins are in place and the surface is locked.

(7) A. F. C. E.

Switches on the pilots' control stand and on the bomber's panel control the A.F.C.E. An attitude control wheel with indicator on the lower left side of the control stand operates the attitude control lever on the A.F.C. gyro through a flexible shaft drive. The control wheel moves through approximately 8.6 turns.

c. POWER PLANT AND FUEL SYSTEM CONTROLS

(1) IGNITION

Two toggle switches are provided on the pilots' panel for ignition cutoff; one switch for each engine. The main ignition switch is on the engineer's switch panel and consists of two four-position switches for individual magneto control and a master switch which controls both magnetos. Ignition may be cut from either the pilot's or engineer's station. Both pilots' and engineer's switches must be ON to start the engines.

(2) THROTTLE

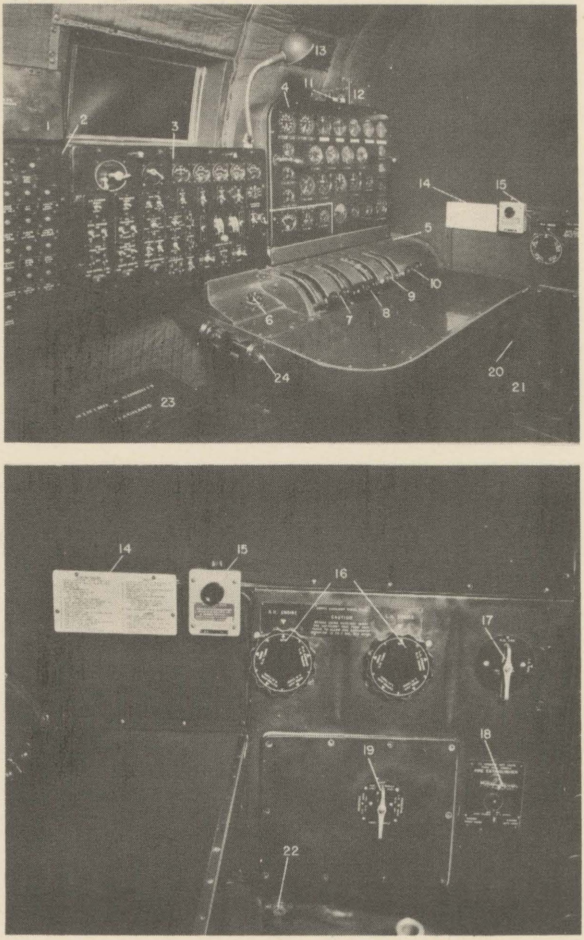
Inter-connected throttle control levers are provided for pilot, co-pilot, and engineer. Controls are connected to the carburetors by a cable system. When additional power is necessary open the throttles smoothly and slowly to prevent over-speeding due to governor lag.

(3) MIXTURE

Mixture control levers, one for each engine, are provided only on the engineer's control stand. The mixture control has four positions: FULL RICH, AUTO. RICH, AUTO. LEAN and IDLE CUTOFF. With the mixture control in any position except IDLE CUTOFF, fuel will flow when the fuel pressure is 5 PSI or more, whether the engine is running or stopped. For this reason the mixture controls should be left in the IDLE CUTOFF position when the engines are idle.

(4) CARBURETOR AIR

The valves in the carburetor air ducts are controlled through a cable system by levers, one for each engine, located on the engineer's control stand. The carburetors are of the non-icing type so that control should be left in the DIRECT position unless atmospheric icing conditions such as heavy rain, sleet or snow are encountered where



1. SPARE LAMPS BOX
2. CIRCUIT BREAKER PANEL
3. SWITCH PANEL
4. INSTRUMENT PANEL
5. CONTROL STAND
6. PROP. PITCH CONTROL
7. SUPERCHARGER CONTROLS
8. THROTTLE CONTROLS
9. MIXTURE CONTROLS
10. CARBURETOR CONTROLS
11. INCLINOMETER
12. TANK SEL. VALVE CONTROL SWITCH & RELAY
13. JUNCTION BOX
14. CHECK-OFF LIST
15. INTERPHONE BOX
16. TANK SELECTOR VALVE CONTROLS
17. INSTRUMENT VAC. CONTROL
18. FIRE EXT. CONTROL- ENG.
19. AUX. P.P. TANK SEL. VALVE CONTROL
20. THERMOSTAT - CABIN HEAT
21. DOOR - DUMP VALVE CONTROLS
22. OXYGEN OUTLET
23. WIRING DIAG. BOX
24. FLASHLIGHT

30162 FIG. 12 ENGINEER'S STATION

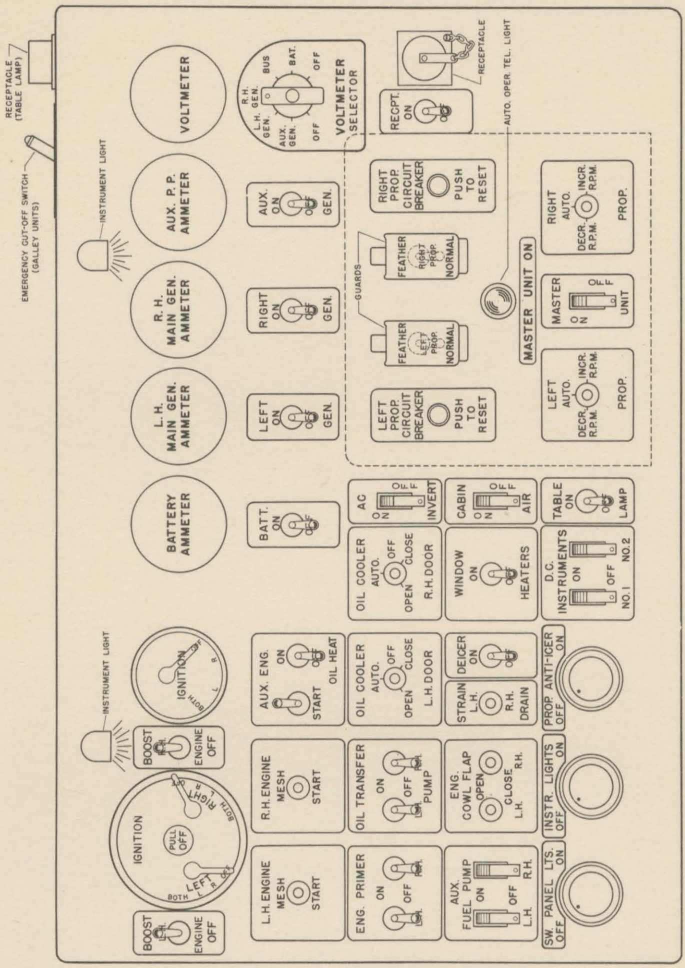


FIG. 13 ENGINEER'S SWITCH PANEL 15-7865

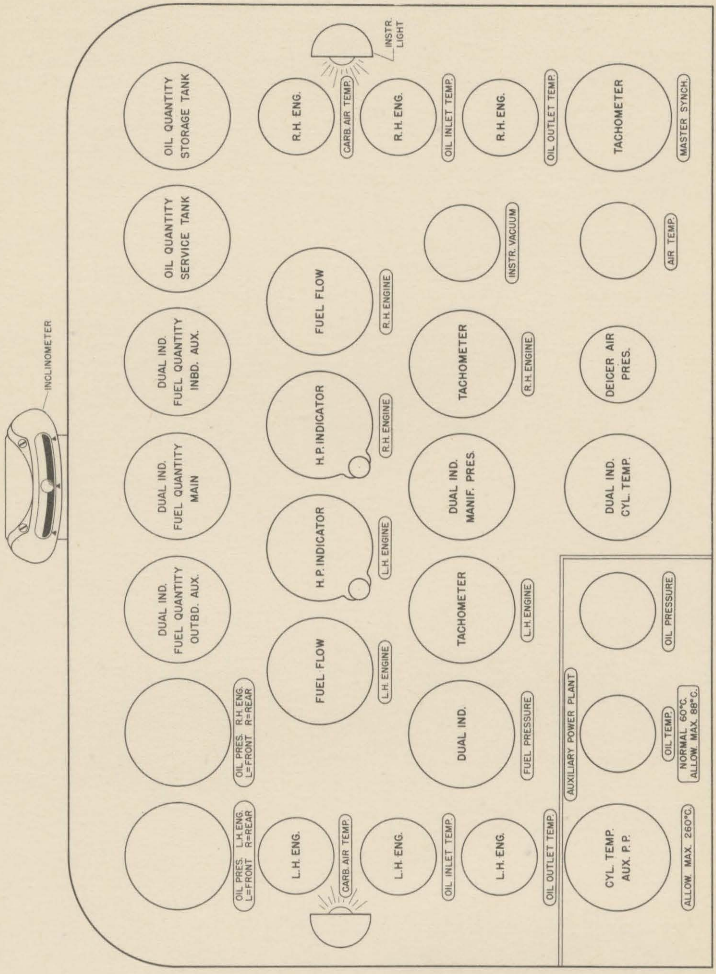


FIG. 14 ENGINEER'S INSTRUMENT PANEL 15-7842

ice may form in the air duct. Under such conditions, the controls should be shifted to the ALTERNATE position to provide carburetor air from a protected source around the manifold. This control shall not be left in an intermediate position. (BuAero T.O. No. 44-40.)

(5) SUPERCHARGER

Two levers on the engineer's control stand operate cable systems to each engine for controlling the superchargers. See cruising control charts for use of superchargers.

When changing from LOW to HIGH ratio, throttle back enough before changing to avoid exceeding the desired manifold pressure. Do not pause while shifting and be sure that lever locks in position after shifting.

(6) THROTTLE BRAKE

The short lever on the top left side of the pilots' control stand operates a friction brake on the throttle drive pulley. By a pawl and sector the brake is locked ON or OFF. The brake is ON with the lever forward.

(7) PROPELLER CONTROLS

(*a*) PROPELLER PITCH

The propeller pitch controls are located on top of the pilots' control stand and at the left end of the engineer's control stand. A cable system connects the two controls and a flexible shaft extends from the drum at the engineer's station to the speed control on the master unit. The master unit controls the RPM (pitch) of the propellers only when the propeller selector switches are on AUTOMATIC.

(*b*) PROPELLER MASTER UNIT SWITCH

The master unit switch on the engineer's switch panel turns the master synchronizer motor ON or OFF. The switch is also an automatic circuit breaker which opens at 10 amperes maximum. The "tel-light" above the switch is on when the master unit is running at the speed for which it was adjusted.

(*c*) CIRCUIT BREAKERS

The push button circuit breakers (25 amperes, thermal bi-metal type) in the propeller control group on the engineer's switch panel protect the propeller control units. The pitch of the propeller cannot be controlled in any manner unless these circuit breakers are on.

(*d*) FEATHERING SWITCHES

Feathering switches are on the engineer's switch panel. In the NORMAL position power is applied to the selector switches and propeller pitch is then controlled by the selector switches. In the FEATHER position power is applied directly to the motor in the hub of the propeller and at the same time the voltage booster is turned on by a series solenoid and its voltage added to the normal voltage to increase the speed of the feathering operation. A limit switch in the propeller hub stops the motor and the voltage booster when the propeller is completely feathered.

(*e*) SELECTOR SWITCHES

The selector switches in the propeller group on the engineer's switch panel provide automatic or manual control of the propeller pitch. Each switch has four positions: OFF (or fixed pitch),

AUTOMATIC, INC. RPM and DECR. RPM.

In the AUTOMATIC position propellers are controlled by the master unit. In the other positions propeller pitch is controlled manually by holding the switch in the DECR. RPM or INCR. RPM positions until the desired speed and/or pitch is attained. Limit switches in the propeller hub stop the operation at high pitch (not fully feathered) and low pitch positions. The center position of the switch is OFF or fixed pitch.

(8) STARTER

The electric direct drive starter is controlled by a single throw momentary switch on the engineer's panel. Because of the impracticability of handcranking this engine, the handcrank takeoff, while present in the starter, is not accessible in this installation.

CAUTION Limit operation of direct cranking to ONE minute. Allow at least one minute for cooling.
Release the switch to open the circuit as soon as the engine starts.

(9) BOOSTER CUTOUT

Booster cutout switches to provide clearing of the combustion chambers are located on the engineer's switch panel. The ignition voltage boosters are normally cut in the system whenever the electrical meshing switch is closed. However when the booster cutout switch is held in the OFF position as the starter is meshed, no spark is furnished to the engine thus preventing the firing of any of the cylinders. Complete clearing of the combustion chambers should be accomplished by three revolutions of the propeller.

(10) PRIMER

The engine primer switches are on the engineer's switch panel. Each switch operates a solenoid valve to release gasoline into the blower case. To prime, hold the switch down until the engine receives sufficient prime (determine by experiment), then release. Do not over-prime. A warm engine needs no priming, since the engine will start when mixture is moved to AUTO RICH.

(11) COWL FLAPS

Two switches on the engineer's switch panel control the cowl flaps for both engines. Switches are OFF in the center and momentarily ON in both extreme positions. Hold the switch up to open flaps and down to close. Limit switches in the motor assembly stop the motor at fully open and completely closed positions. Adjust the flaps to obtain the proper cylinder head operating temperature. Do not attempt to shorten the warmup period by running the engine with flaps closed as this may result in cylinder fin cracking due to difference in temperature between the forward and rearward portions of the fin.

(12) OIL COOLER DOOR

Two switches on the engineer's switch panel control four positions: OFF, OPEN, CLOSE and AUTO. With the control switch on AUTO the oil cooler door is controlled by automatic thermal and pressure switches in the oil system. The two lower positions of the switch (OPEN and CLOSE) are momentary and provide manual control of the door. Limit switches in the motor assembly stop the motor at fully open and completely closed positions. Oil cooler doors are normally controlled automatically but if manual control should be necessary the doors should be kept open only enough to provide sufficient oil cooling. Any excessive opening merely causes the oil cooler outlet valve to by-pass a portion of the oil directly to the tank with consequent excessive cooling drag.

(13) OIL TRANSFER PUMP

Electric pumps which transfer oil from storage to service tank in either wing are controlled by switches on the engineer's panel. Pumps are slightly larger than necessary to provide oil as used by the engine. Observe service oil tank gauges carefully while transferring oil to avoid overflow.

(14) FUEL TANK SELECTOR VALVE

Fuel tank selector valve controls are at the engineer's station on Bulkhead 364. They are connected through cable systems to

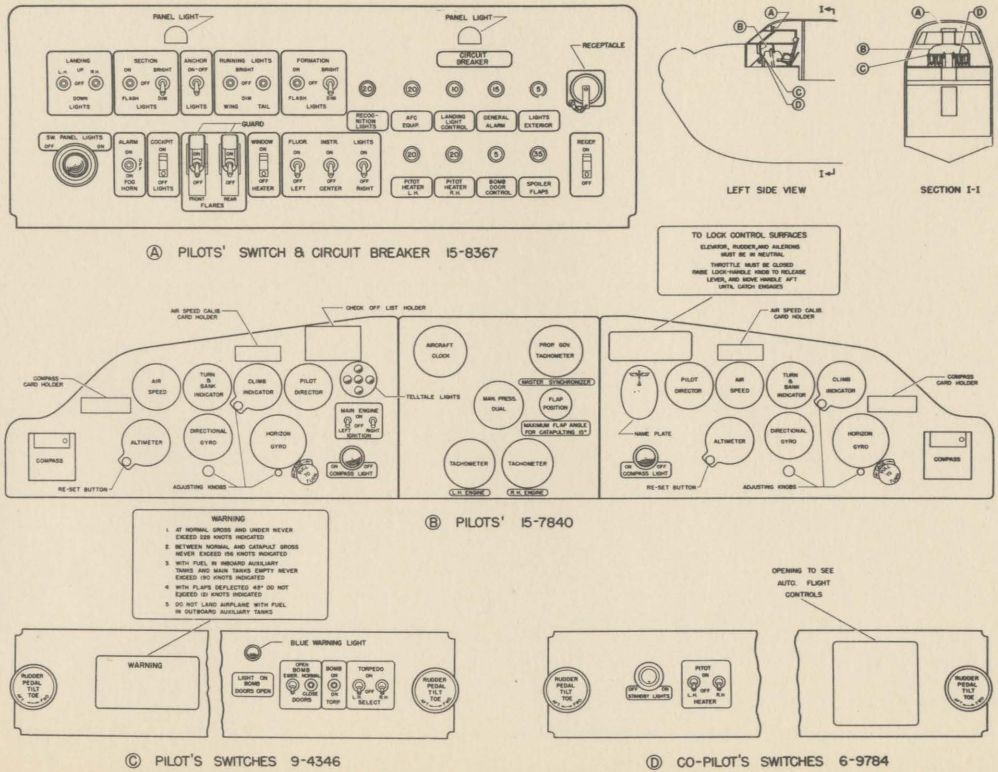


FIG. 15 PILOTS' INSTRUMENT AND SWITCH PANELS

the valves of the nacelles. Controls do not rotate through 360° but advance in increments of 72° from OFF through four other valve positions and back to OFF. A cam and sliding pin lock assembly between controls prevents both valves being accidentally adjusted to cross feed at the same time, which would stop the fuel supply to both engines.

The carburetor overflow or vapor return line leads to the main tank. The fuel return to the tank by this means may amount to five to seven gallons per hour (approx.). Therefore to avoid overfilling the main tank on extended flights when auxiliary tanks are being emptied, enough fuel should be used from the main tanks *first* to provide room for overflow from the carburetors. Because of the return of fuel from the carburetor there is an apparent slight increase in fuel consumption when other than the main tanks are being used. See also Sec. 5, par. (4).

(15) AUXILIARY FUEL PUMP

Auxiliary electric fuel pumps in the nacelles are used for starting the engines, for high altitude flight or for use in case the engine pump fails. Control switches are on the engineer's switch panel.

(16) STRAINER DRAIN

The fuel strainer drain valves on the front side of Bulkhead 364 below the main deck are solenoid operated and controlled by momentary switches on the engineer's switch panel. The strainers should be drained in flight immediately before landing and immediately after takeoff to clear the strainer and the line of water and prevent freezing. Opening the valve a few seconds should be sufficient to clear the line.

d. ELECTRICAL AND RADIO CONTROLS

(1) A. C. INVERTER

A circuit breaker switch on the engineer's panel controls power to the inverter. The engine A.C. instruments, which include all fuel pressure, oil pressure, manifold pressure and torque meter instruments, are on whenever the inverter is on.

(2) D. C. INSTRUMENTS

Power to D.C. instruments is controlled by two 5 ampere circuit breaker switches on the engineer's switch panel. D. C. instruments include fuel quantity gages, oil quantity gages, flap position indicator, all oil temperature instruments and air temperature instruments.

(3) PITOT HEATERS

Two switches on the copilot's switch panel control power to the pitot heaters through the operation of relays. Circuit breakers for the pitot heater circuits are on the pilots' switch panel.

(4) LANDING LIGHTS

Two switches on the pilot's switch and circuit breaker panel control extension and retraction of the landing lights. The lamps are energized automatically through separate circuits when the lights are in the extended position.

(5) SECTION LIGHT

The section light on the top center of the hull at Station 645 is controlled by two switches on the pilot's switch and circuit breaker panel. With one switch, the light may be turned ON or OFF, or flashed with a momentary contact. The second switch adjusts the light for BRIGHT or DIM.

(6) ANCHOR LIGHTS

Four anchor lights and the tail light are operated through a sequence relay. Control switches are momentary contact and must be held on until the lights go on or off as desired (less than one second). One control switch is a toggle switch on the pilot's switch and circuit breaker panel, and the other is a micro-switch under a pressure disk in the hull aft of the port main entrance door.

(7) RUNNING LIGHTS

The running lights are controlled by two toggle switches on the pilot's switch and circuit breaker panel. One switch controls the wing tip lights and the other switch controls the tail light. Each switch has three positions: OFF, DIM and BRIGHT.

(8) FORMATION LIGHTS

Formation lights are controlled by two toggle switches on the pilot's switch and circuit breaker panel. One switch controls the lights between BRIGHT, DIM and OFF. The other switch provides for a steady light or a momentary flash signal.

(9) RECOGNITION LIGHTS

Pilot operated recognition lights are installed near the outboard end of the right wing; one white light in the upper surface, one red, one green and one amber in the lower surface. Control switches are in a small shield at the left end of the pilot's switch and circuit breaker panel. A keying switch and individual switches for each light provide steady or momentary lights or both in any combination desired.

(10) FLUORESCENT INSTRUMENT LIGHTS

The pilot's fluorescent instrument lights are controlled by separate switches on the pilot's switch and circuit breaker panel. The inverter must be ON to supply power for the lights. The intensity of the near ultra-violet illumination of the instrument panel is adjustable by rotating the lamp assembly to any set of the various sized openings provided in the screen.

(11) INSTRUMENT PANEL LIGHTS

A rheostat on each of the pilot's and copilot's switch panels controls a light in each of their respective compasses.

Two panel lights on the pilot's control stand and a control stand standby light mounted on the pilot's switch and circuit breaker panel are all controlled by a rheostat on the rear face of the control stand.

Two lights on the pilot's radio panel are controlled by a rheostat on the radio panel.

The bomber's instrument lights and switch panel lights are controlled by two rheostats on the bomber's switch panel. A separate light and rheostat control provide illumination for the intervalometer panel. The bomber's standby light, which may also be used to illuminate the bomber's compartment, is controlled by a switch on the bow turret control shield.

The engineer's instrument lights and switch panel lights are controlled by two rheostats on the engineer's switch panel.

Spare bulbs for the instrument lights are carried in a shield above the engineer's instrument board. Spares are carried for the fluorescent lights, compass lights, standby lights, telltale lights, bomber's instrument panel lights and for the engineer's instrument board lights.

(12) CIRCUIT BREAKERS

The electrical feeder bus to the engineer's panel and the bus to the waist turrets and upper turret are protected by fuses in a shield on Bulkhead 364 in the galley. Spare fuses are carried in the shield. All other electrical circuits are protected by thermal bimetal type circuit breakers of the push button type or toggle switch type. The handle of the toggle switch type returns to the OFF position when the circuit is overloaded, thus giving an indication when the circuit is open. In the push button type there is no indication that the circuit has opened. When equipment is inoperative, test the circuit by

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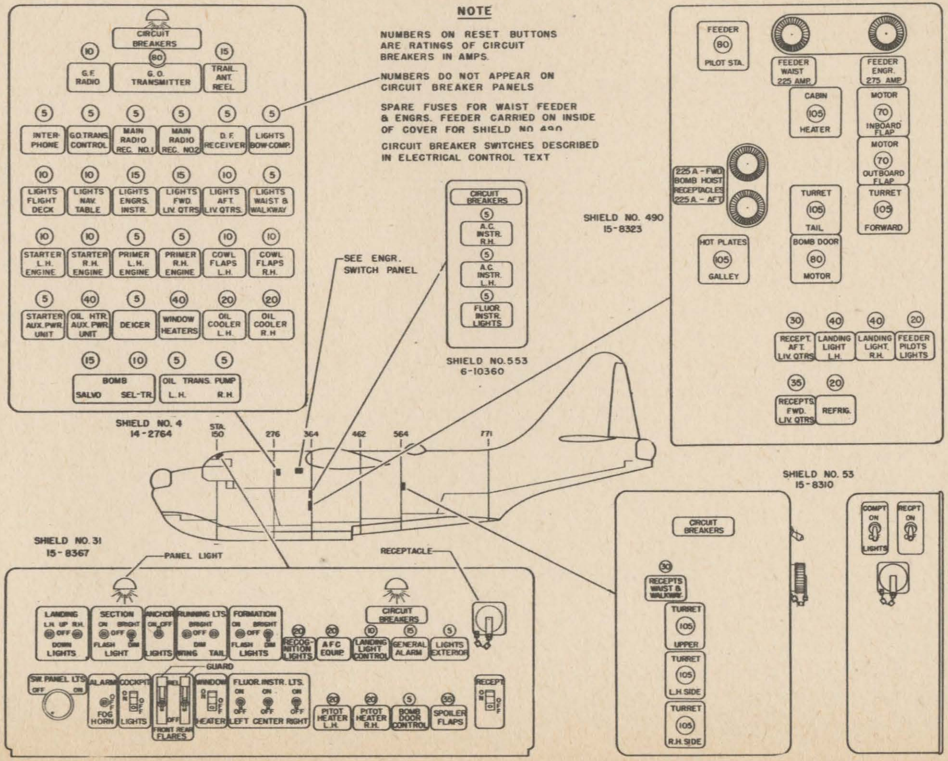

FIG. 16 FUSE & CIRCUIT BREAKER LOCATION CHART

pushing the button in. If the equipment is still inoperative, the trouble is probably in the equipment. Circuit breakers cannot be held in against overload. Approximately six seconds time is required for cooling after tripping before they may be reset.

A nameplate under each circuit breaker identifies the circuit it protects. Locations are as shown in Figure 16. For location of fuses in radio and interphone equipment see manufacturer's instruction manuals.

(13) ALARM HORN—FOG HORN

The alarm horn is controlled from momentary contact toggle switches, one on the pilot's switch and circuit breaker panel and one at the commander's station. Switches are OFF in center and momentarily ON in both extreme positions. In the up position the switches operate the alarm horn and in the down position they operate the fog horn. The alarm horn becomes a fog horn when mounted on the outside of the hull aft of the anchor hatch.

(14) COMMUNICATION EQUIPMENT—See Figure 17

(*a*) INTERPHONE

The interphone set is a Type RL-24B which serves 15 stations. This equipment provides communication between all gunners and flight crew stations and a station in each of the officer's and crew's quarters and at Station 956 at the drift sight station by the aft mooring hatch. Individual non-interacting volume level control means are provided for each station.

Means are provided, under the radioman's control, for disconnecting one or both earphones of his headset from the interphones and connecting the earphones in on either one or both of the main radio receivers.

By means of the pilots' control box, one or both earphones and the microphone of either pilot may be disconnected from the interphone and connected to the intrasquadron radio.

By using the recall button on the pilots' control box which flashes a light in front of the radioman, either pilot may recall the radioman to the interphone at times when both earphones of the radioman may be disconnected from the interphone.

For the purpose of homing, either or both pilots may listen to the output from the main radio receiver (mixed with voice communication) provided a switch operated by the radioman is closed.

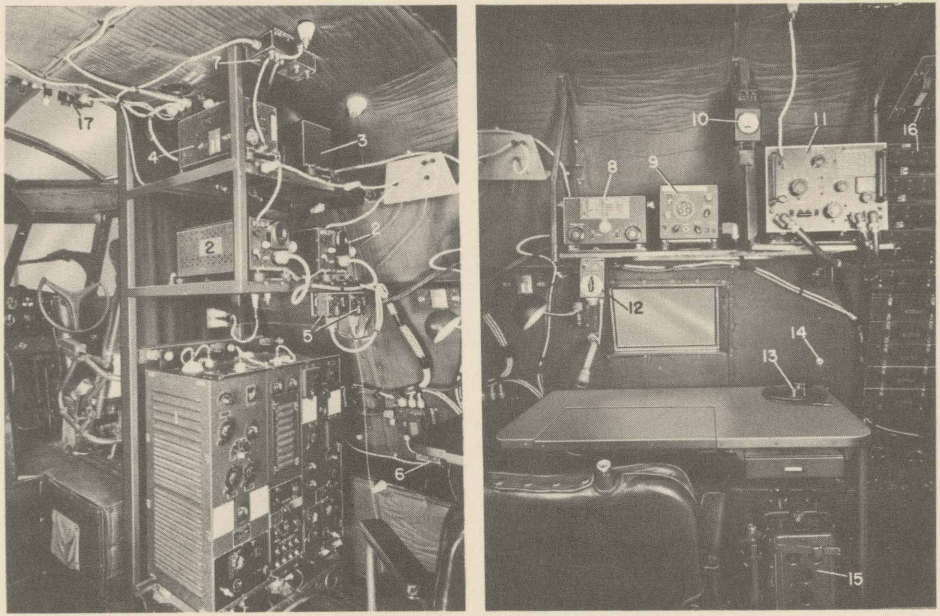

FIG. 17 RADIO OPERATOR'S STATION

1- GO-5 TRANSMITTER
2- RU-12 RECEIVER
3- RU-14 RECEIVER
4- GF-9 TRANSMITTER
5- RECEIVER CONTROL BOX
6- INTERPHONE BOX
7- ANTENNA RELAY
8- INTERPHONE CONTROL
9- FREQUENCY INDICATOR
10- OUTPUT METER
11- DIRECTION FINDER-RECEIVER
12- ANTENNA REEL CONTROL
13- KEY-MAIN RADIO
14- OXYGEN OUTLET
15- RE-BREATHER
16- SPARE COILS
17- PILOTS' RADIO CONTROLS

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2701

(*b*) RADIO

The intrasquadron radio equipment consists of a Type GF-9 transmitter and a Type RU-14 receiver controlled by the pilots, but which may also be used by the commander and navigator. Other radio equipment includes a Type GO-5 transmitter, two Type RU-12 receivers and a Model DZ-1 direction finder, all controlled by the radioman.

e. ARMAMENT CONTROLS

Before any bombs may be released, the spoiler flaps must be extended and the bomb doors opened. Spoiler flaps and bomb doors operate in conjunction from the same switch except in emergency when bomb doors may be opened by themselves.

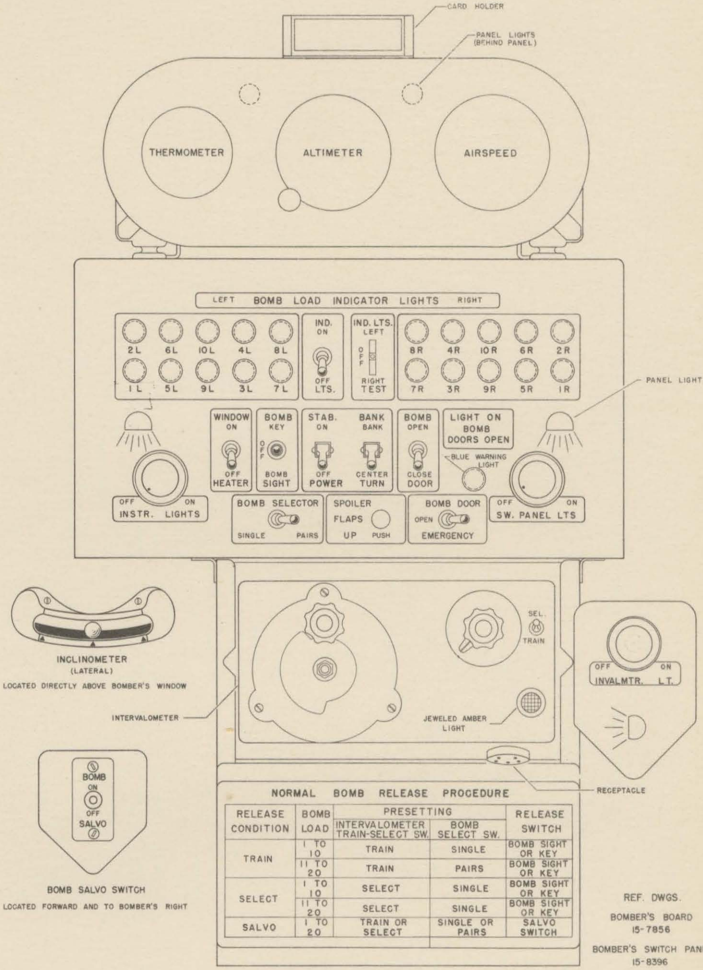
The three positions of the switches on the pilot's and bomber's switch panels control the spoiler flaps and bomb doors electrically. When the momentary switch is held in the OPEN position, the spoiler flaps extend until halted at 30° by limit switches. When both sets of spoiler flaps have opened, the circuit to the bomb door motor is completed and the bomb doors will open. Limit switches halt the bomb doors in the fully open position.

If either set of spoiler flaps fails to operate, the bomb doors must be opened by the bomb door emergency *opening* switch located on both the pilot's and the bomber's switch panels.

NOTE: When a full bomb load is carried necessitating flight with bomb doors OPEN, the spoiler flaps may be retracted to reduce drag. When the bomb door closing switch is actuated following the release of bombs, the spoiler flaps will automatically extend before allowing movement of the bomb doors. Upon complete extension of the spoiler flaps, the bomb doors will close. Spoiler flaps may again be retracted after the doors have closed.

A cable attached to an actuator at the upper end of the bomb door track unlocks a release mechanism and simultaneously operates a safety switch in the release circuit when the bomb doors are in the fully open position, thus preventing bombs from being released prematurely.

The bomb door indicator lights on the pilot's and the bomber's switch panel will glow when the bomb doors are open and the bomb door operating switch is *held* in the OPEN position. The lights will go out when the switch is released.



NORMAL BOMB RELEASE PROCEDURE

RELEASE CONDITION	BOMB LOAD	PRESETTING: INTERVALOMETER TRAIN-SELECT SW.	PRESETTING: BOMB SELECT SW.	RELEASE SWITCH
TRAIN	1 TO 10	TRAIN	SINGLE	BOMB SIGHT OR KEY
	11 TO 20	TRAIN	PAIRS	BOMB SIGHT OR KEY
SELECT	1 TO 10	SELECT	SINGLE	BOMB SIGHT OR KEY
	11 TO 20	SELECT	SINGLE	BOMB SIGHT OR KEY
SALVO	1 TO 20	TRAIN OR SELECT	SINGLE OR PAIRS	SALVO SWITCH

36204 FIG. 18 BOMBER'S INSTRUMENT & SWITCH PANEL

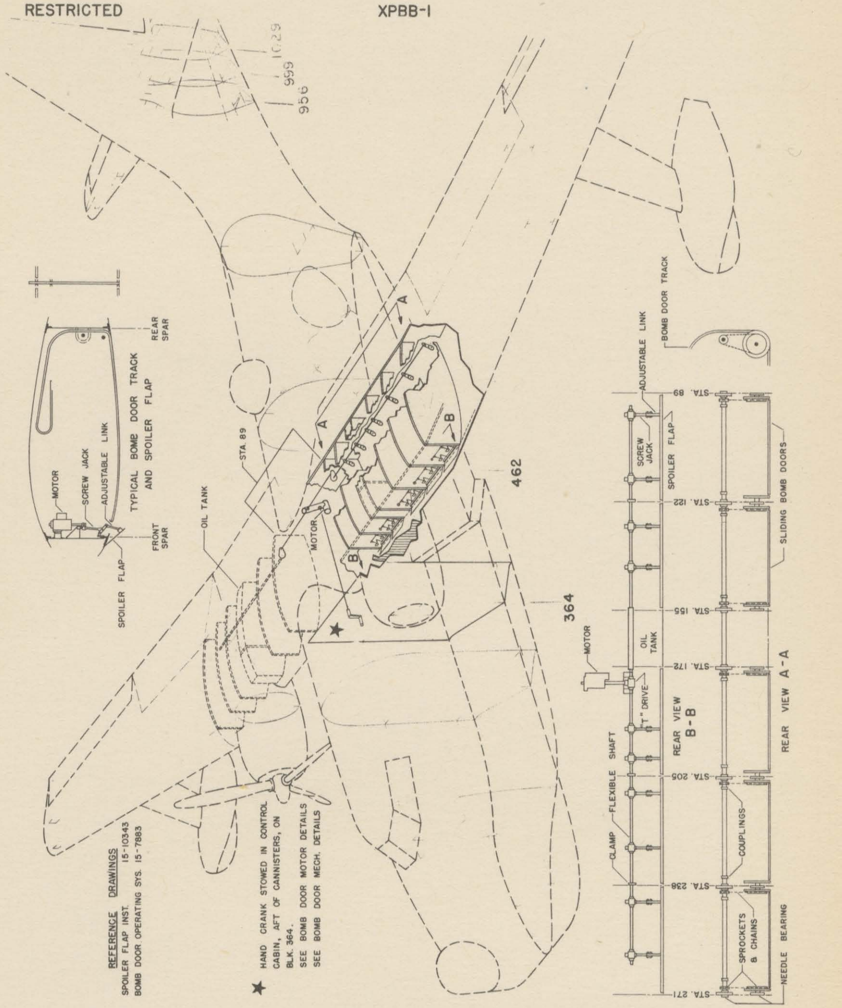


FIG. 19 BOMB DOOR AND SPOILER FLAP OPERATING SYSTEM

NOTE: If bomb doors have been open in flight, they should be checked for full open position immediately prior to releasing bombs, since they tend to creep shut in flight. A second operation of the bomb door opening switch should be made to make sure that the doors are full open before releasing any bombs.

Doors may be manually operated by a crank that may be attached to the mechanism on the bulkhead at the engineer's station. The crank is stowed in the control cabin on Bulkhead 364.

Release of bombs electrically may be accomplished from the bomber's firing key or from the pilot's firing key after the intervalometer has been set.

Both the bomber and the pilot have bomb release levers controlling the same cable system. Both levers have three positions: SAFE, ELECTRICAL, and SALVO. In the SAFE position all release units are locked in the cocked position and no bombs may be dropped. In the ELECTRICAL position the release units are unlocked and bombs may be released electrically from the firing keys at either the pilots' or the bomber's station, although the bomber alone has control of the selection of bombs in the number desired. The SELECT or TRAIN release is regulated by the intervalometer settings on the bomber's panel. With the intervalometer set for SELECT release (one at a time), do not close the circuit for more than 5 seconds at a time. Bombs may be electrically released in SALVO by the bomber only, from a switch located above the right side of the bomber's window. Sequence of release in electrical salvo is from outboard bays to inboard through consecutive bays but release is so rapid that it is practically instaneous. If any door sticks, that bay will automatically be by-passed and the other bays will empty as usual.

The delay which occurs from the time the electrical release is initiated until the bomb actually leaves the rack has not been established at this writing. This information will be made available following the findings of the Trial Board.

The SALVO position of the release levers acts as an emergency mechanical release, connected to the bomb bays by a cable system. By depressing, pulling out and pushing the control lever through to the SALVO position from the ELECTRICAL position, all bombs are released simultaneously, unarmed. If any door fails to open, the release mechanism will remain locked and the release lever will fail to move under ordinary pressure. By exerting extra pressure on the lever, it is possible to sever a shear pin on the quadrant assembly, by-passing that particular bay but releasing all of the bombs in the remaining bays.

100 pound bombs on the auxiliary racks may be released electrically only.

Torpedoes, when carried, may be released only by the pilot. A switch on the pilots' switch panel allows choice to be made between bombs and torpedoes. A second switch allows a selection between right or left-hand torpedoes. Torpedoes are only to be dropped by means of the pilot's electrical firing key mounted on the left side of the pilots' control stand, except in emergency when they may be dropped by the emergency mechanical bomb release.

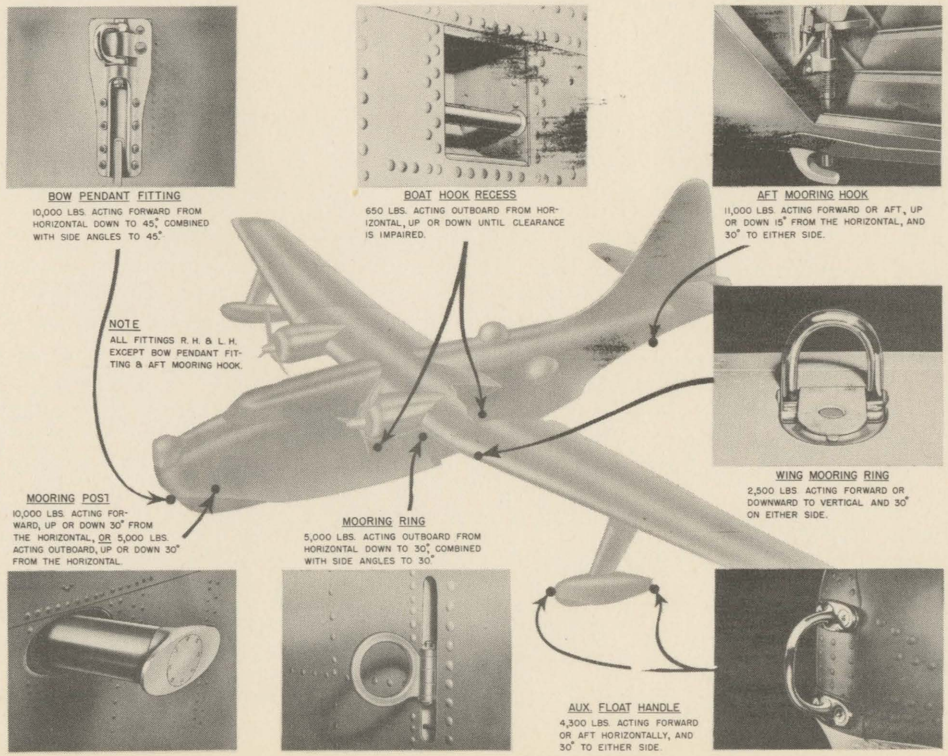


FIG. 20 MOORING FITTINGS- ALLOWABLE LOADS

3. EQUIPMENT–DESCRIPTION AND CONTROLS

a. SEAT ADJUSTMENT—See Fig. 10

Swivel arm chairs are provided for the bomber, radioman, commander and engineer. The lever for unlocking the swivel is under the edge of the seat.

Pilot's and copilot's seats are adjustable fore and aft, and up and down, with levers under the edge of the seat to control the locks. The tilt of the backs is adjustable to three positions with the lock handle at the side of the seat.

b. TOWING AND MOORING FITTINGS

For towing the airplane on the water or for mooring the airplane to a buoy, an oval shaped tow ring is attached to the pendant clamp terminal on the end of the pendant line. When the airplane is to be anchored, the tow ring should be removed and the pendant cable attached to the pendant clamp by means of the same bolt and nut used for attaching the tow ring to the cable terminal. The anchor line should then have the pendant clamp attached loosely to it before the anchor is dropped. After dropping the anchor to the desired depth the clamp should be tightened and dropped overboard so that the pendant cable takes the load off the anchor davit. The lizard line may be used to retrieve the pendant line when the anchor is to be weighed.

The airplane may be towed backward or moored from the aft mooring fitting at Station 956. The lever for operating the pin in the fitting may be reached under a a floor panel from inside the hull or through the aft mooring hatch from outside the hull.

The mooring posts at Station 76 on either side may be extended from inside the bow compartment. To extend them, withdraw the locking pin, push the post outward and turn one-quarter turn. Reinsert the locking pin through the end of the post.

When on the beaching gear, the airplane may be towed by using the tow ropes attached to the two forward units.

For locations of other towing and mooring fittings, see Figure 19.

c. AUXILIARY POWER PLANT—Electrical

(1) DESCRIPTION

The auxiliary power plant consists of a horizontal air cooled, 5 cylinder radial engine driving an 8-kilowatt generator. The plant is designed to furnish electrical power during surface operation for normal galley operation, heating system, radio operation and engine starting and under defense conditions for turret operation. The auxiliary power plant will normally be turned off after take-off when electrical power may be supplied from the main engine generators.

Controls including starter switch, ignition switch, oil heater switch and generator switch are on the engineer's switch panel. The fuel selector valve on Bulkhead 364 allows fuel to be drawn from the cross-supply line or from the 12½ gallons reserve in either main tank. Fuel will normally be taken from the cross-supply line so that the reserve in each main tank will be available for emergency use.

The carbon dioxide fire extinguisher system for the auxiliary power plant is automatic and manually controlled. The manual control handle is on Bulkhead 150 in the officers' quarters. After use the supply cylinder of CO_2 must be replaced as soon as possible.

Engine and generator details are as follows:

Lawrance Engineering & Research Type	Model 75B Radial (Vertical Shaft)
No. of Cylinders	5
Bore	2.625″
Stroke	2.75″
Displacement	75 Cu. In.
Compression Ratio	9 : 1
Normal RPM	4000±100
Crankshaft Rotation	C.C. from generator end
Maximum Cylinder Head Temperature	260°C. (500°F.)
Maximum Continuous Power	8 K.W. (28.5 Volts)
Overload Rating (5 minutes)	12 K.W.
Ignition—Dual Scintilla	SF5R-6, SF5R-10
Fuel	100 Octane
Fuel Pressure	3–5 PSI
Fuel Consumption	10.4 Lbs./Hr.
Oil	Grade 1065 to 1080
Oil Pressure	55–65 PSI
Oil-in Temperature desired	60°C. (140°F.)
Oil-in Temperature maximum	88°C. (190°F.)

(2) OPERATION

(*a*) STARTING

1. Check battery voltage by adjusting voltmeter selector switch to BATT.

2. Open fuel valve to CROSS SUPPLY ON. (At least one main tank selector valve must also be open.)

3. Turn ignition switch on BOTH.

4. Push starting button down until engine begins to fire, then release.

5. As soon as the engine starts, observe oil pressure. If no pressure is indicated within a few seconds, shut the engine off and investigate. The engine idles at about 1800 RPM when starting in cold condition; therefore, oil pressure will be somewhat less than normal (55 to 65 PSI) until normal speed is attained.

CAUTION: If engine has been idle for one week or more, it should be cranked through three or four revolutions manually to make certain liquid has not collected in the combustion chambers. If abnormal effort is required in cranking, remove the lower spark plug from each cylinder to drain any liquid that may have collected in the combustion chamber.

(*b*) MANUAL STARTING (By a crew man at Aux. P.P.)

1. Loosen and remove cover plate over manual starting hole.

2. Insert the starting drum shaft until it engages the shaft at the end of the generator.

3. Signal engineer to open fuel valves and turn on ignition.

4. Wrap the rope around the starter drum and pull all the way through. Repeat until engine starts.

(*c*) WARM-UP

When the operating temperature is below 70°F, the engine will idle at about 1800 RPM after starting. As the oil warms, the engine speed will gradually increase to 4100 RPM (no load). The governor is adjusted to operate between 3900 RPM (full load) and 4100 RPM (no load). During warm-up the engine oil heater should be turned to ON. Normal operating oil-in temperature should be about 60°C. and should not be permitted to exceed 88°C. DO NOT USE OIL HEATER BEFORE STARTING ENGINE. Load may be applied to the generator as soon as the engine comes up to speed by turning the generator switch ON. Check generator voltage as soon as switch is turned on.

(*d*) OVERSPEED

Attached to one of the two magnetos is an overspeed cutout assembly which grounds both magnetos when the engine speed reaches 4800 RPM. Do not try starting the engine after failure without first resetting the overspeed button, then proceed with caution.

(*e*) STOPPING THE ENGINE

1. Turn auxiliary power plant generator OFF.
2. Allow engine to idle for one-half minute.
3. Turn ignition switch OFF.
4. Turn fuel valve OFF.

d. INSTRUMENT VACUUM

A valve on Bulkhead 364 at the engineer's station provides for selection of the vacuum pump on either engine for operation of the gyro instruments. The vacuum pump on the other engine is then automatically connected to the deicer system. (See Fig. 10)

e. SURFACE DEICER AND PROPELLER ANTI-ICER

The surface deicer system is controlled by a single switch on the engineer's switch panel. An electric timer, a solenoid-operated pressure-relief and unloading valve and an auxiliary solenoid unloading valve are the units controlled by the switch.

The engine driven deicer air pumps in each nacelle operate whenever the engine is running, but in the deicer OFF position, all their output is relieved overboard by the unloading valves. Closing the engineer's switch energizes the solenoid, closing the unloading valve and auxiliary unloading valve, and energizes the timer, putting the system in operation.The normal operating pressure of the system is 7 PSI. If the pressure builds up higher than 7 PSI, the spring-operated pressure relief port of the solenoid unloading valve opens and allows the excess pressure to escape. A deicer air gage on the engineer's instrument panel allows the engineer a constant check of pressure within the system.

Pressure from the pumps goes to individual manifold valves at the inboard end of each boot. The manifold valves are actually dual units in one housing since one unit of the valves controls the first inflation of the boot and the other unit controls the second inflation. Corresponding stations on both wings are connected electrically so as to provide symmetrical operation of the deicers. With the deicers OFF but the engines operating, the vacuum in the system always holds the deicer boots smoothly against the leading edge of the wing.

A rheostat with an OFF position located on the engineer's switch panel controls the propeller anti-icer pump. The pump has two outlets and is mounted directly below the 15 gallon tank of anti-icing fluid in the galley. The pump sends fluid directly to the slinger ring of each propeller. No provision is made to turn off the supply to one propeller when feathered, while the other propeller is operating.

f. CABIN HEATER—See Figure 20

The cabin heater is a Stewart Warner heating and ventilating unit using 100 octane gasoline from the cross-supply line. An electric motor drives both the centrifugal fan which forces heated air to the airplane compartments, and the roots blower which supplies the heater with the fuel-air mixture at the required pressure. Cabin air temperature is regulated automatically by an adjustable thermostat at the engineer's station. The fuel valve is solenoid operated. Ignition of the burner is electric and automatic. The complete system is controlled by a circuit breaker switch on the engineer's switch panel.

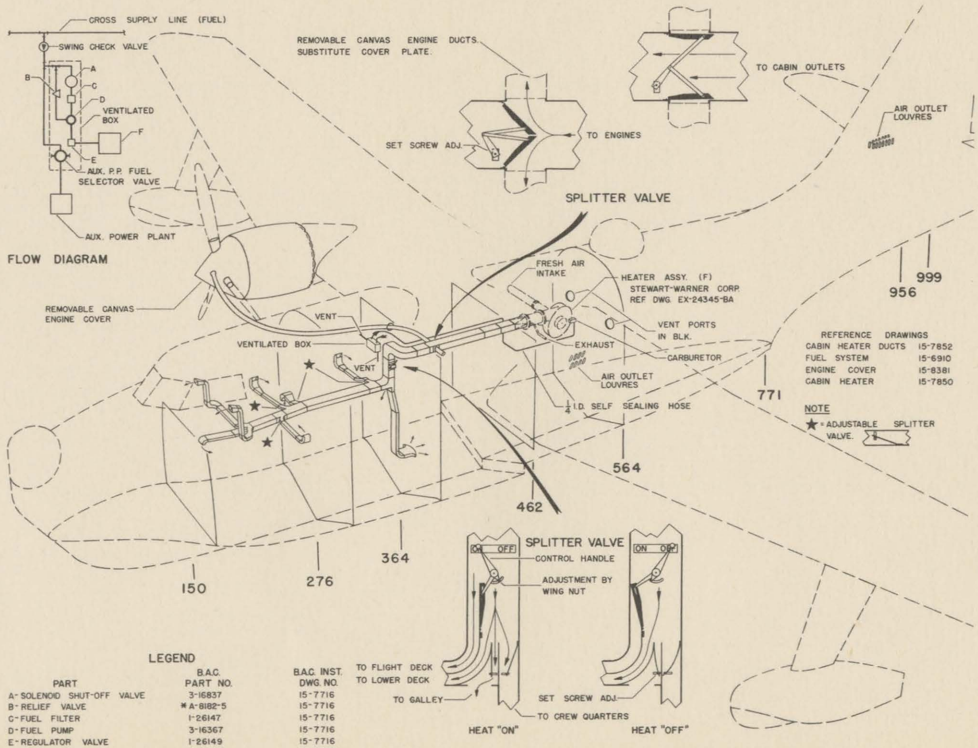
Heated air to the control cabin is controlled by a valve in the duct at the front spar bulkhead operable from the engineer's station.

Canvas ducts for the engine heater may be attached to the main duct in the crew's compartment by removing the cover plates on the sides of the duct. Holes with cover plates are provided in the hull sides above the main entrance doors through which the canvas ducts extend to the engine covers. A valve in the duct forward of the engine heater duct connection may be closed to direct all heated air to the engines for warm-up.

g. WINDSHIELD HEATERS—See Figure 21

Two windshield heaters are provided: One for heating the bomber's window and one for heating both the pilot's and copilot's windshields. A master switch at the engineer's station opens a fuel-air mixture solenoid valve at the left-hand engine blower casing and energizes the electrical circuits up to the pilots' and bomber's switches. The pilot and the bomber each have a switch for control of their own heaters in addition to a plug valve in the fuel-air line near each heater. Each heater is electrically ignited and automatically controlled.

The bomber's heater, in addition to heating the bomber's window, may also be used to heat the bow compartment.



REFERENCE DRAWINGS

CABIN HEATER DUCTS	15-7852
FUEL SYSTEM	15-6910
ENGINE COVER	15-8381
CABIN HEATER	15-7850

NOTE
★ = ADJUSTABLE SPLITTER VALVE.

LEGEND

PART	B.A.C. PART NO.	B.A.C. INST. DWG. NO.
A-SOLENOID SHUT-OFF VALVE	3-16837	15-7716
B-RELIEF VALVE	* A-8182-5	15-7716
C-FUEL FILTER	1-26147	15-7716
D-FUEL PUMP	3-16367	15-7716
E-REGULATOR VALVE	1-26149	15-7716
F-HEATER ASSY.	3-15055	15-7850

* ADEL PART NUMBER

FIG. 21 CABIN HEATING SYSTEM

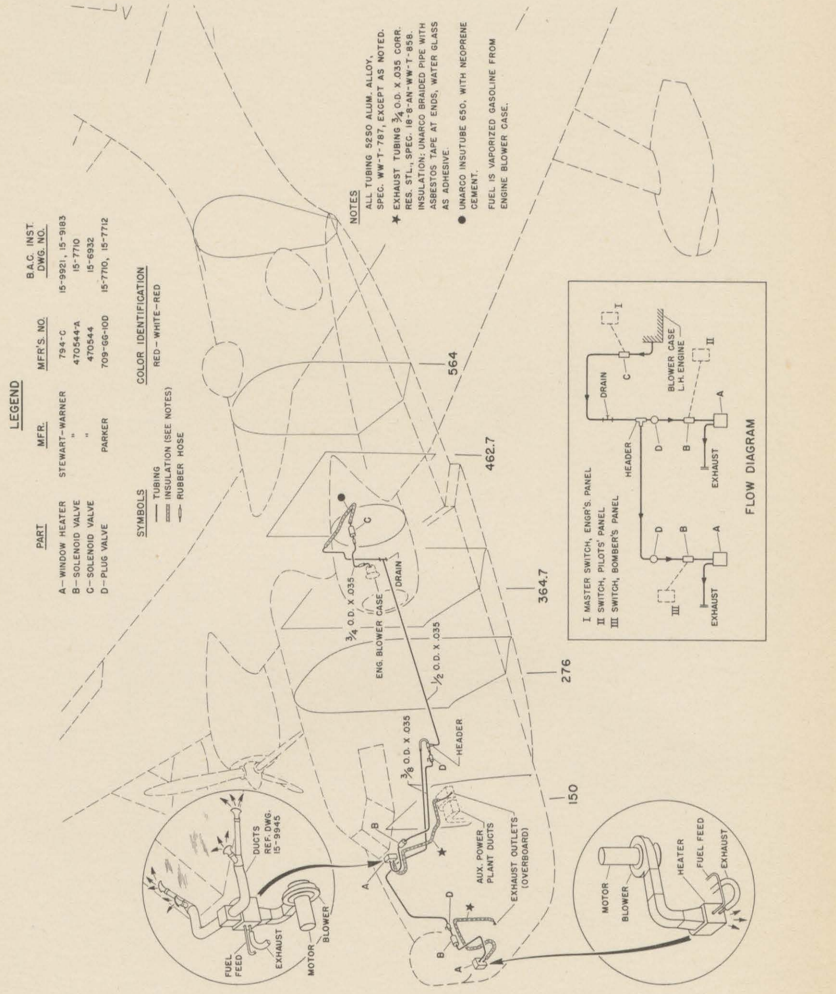


FIG. 22 WINDSHIELD HEATER SYSTEM 15-9523

22940
1837

h. FUEL DUMP VALVES

Fuel dump valves and the tail pipes are controlled by four levers located on Bulkhead 364 behind a small panel near the deck. Each lever controls a separate cable system operating the dump valve and tail pipe on a single fuel tank (main tanks and outboard auxiliary tanks only are equipped with dump valves). After fuel has been dumped, the valves may be closed and the tailpipes retracted. See also Sec. V, Par. 4 b.

CAUTION: Do not dump fuel when the flap angle exceeds 15° as there is danger of fuel not clearing the flaps.

i. ENGINE FIRE EXTINGUISHER

The selector valve, through which the carbon dioxide discharge may be directed to either engine, and the pull handle for releasing the discharge are located on Bulkhead 364 at the engineer's station. The CO_2 supply is one 12.5 pound cylinder on Bulkhead 364 in the galley. After use, always recharge or replace the cylinder before attempting to start another engine.

j. VAPOR DILUTION SYSTEM

After fuel has been dumped, carbon dioxide gas may be released into the outboard auxiliary fuel tanks by means of two pull handles located on Bulkhead 364 at the engineer's station. Two twenty pound cylinders of CO_2 on Bulkhead 364 in the galley furnish the gas for the vapor dilution. If vapor dilution is started before all fuel is dumped, CO_2 gas may be forced out the vent.

CAUTION: Do not start vapor dilution until the fuel has all been jettisoned and the dump valves are closed.

k. FLARE RELEASE

Parachute flares may be released electrically from two switches on the pilots' switch and circuit breaker panel, or manually at each flare tube in the accessory compartment. In either case, the tubes must be cocked and loaded manually in the accessory compartment. To cock the flare release mechanism, force the release handle outboard until the spring-loaded plunger drops into place. To release the flares manually, pull the release handle inboard.

CAUTION: Since flares are easily damaged by moisture, always remove flares from tubes and replace watertight covers on tubes before landing.

l. OXYGEN SYSTEM—(See Figure 22.)

The oxygen system is a central supply, multiple distribution type

FIG. 23 OXYGEN SYSTEM 15-6928

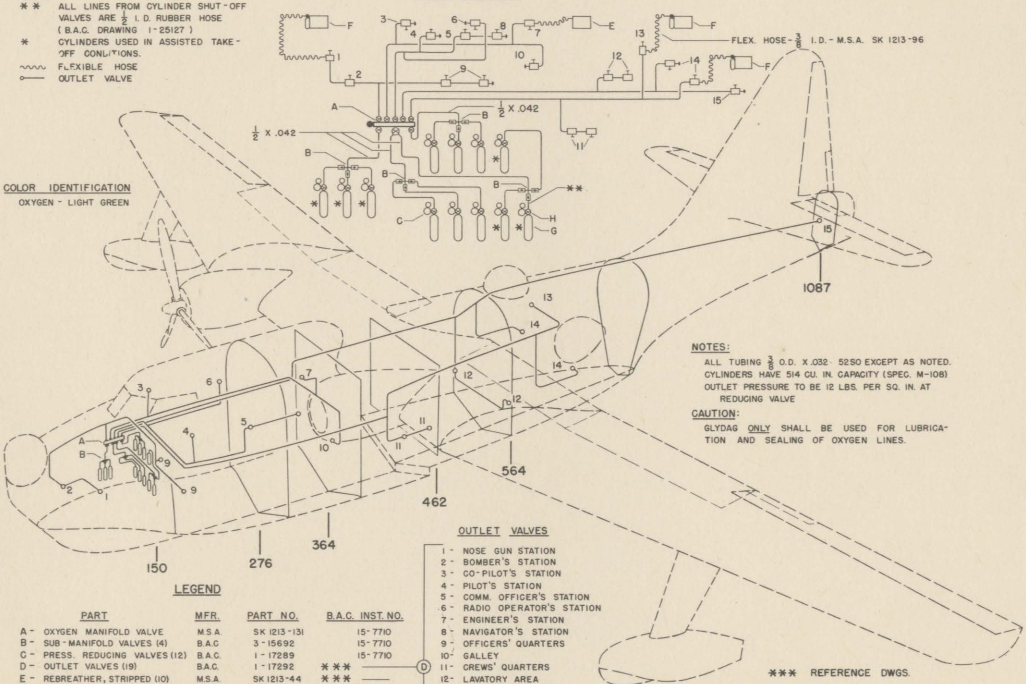
SYMBOLS

- ** ALL LINES FROM CYLINDER SHUT-OFF VALVES ARE $\frac{1}{2}$ I. D. RUBBER HOSE (B.A.C. DRAWING 1-25127)
- * CYLINDERS USED IN ASSISTED TAKE-OFF CONDITIONS.
- ~~~ FLEXIBLE HOSE
- o— OUTLET VALVE

COLOR IDENTIFICATION

OXYGEN - LIGHT GREEN

FLOW PATTERN



NOTES:

ALL TUBING $\frac{3}{8}$ O.D. X .032 - 52SO EXCEPT AS NOTED.
CYLINDERS HAVE 514 CU. IN. CAPACITY (SPEC. M-108)
OUTLET PRESSURE TO BE 12 LBS. PER SQ. IN. AT REDUCING VALVE

CAUTION:

GLYDAG ONLY SHALL BE USED FOR LUBRICATION AND SEALING OF OXYGEN LINES.

LEGEND

	PART	MFR.	PART NO.	B.A.C. INST. NO.
A -	OXYGEN MANIFOLD VALVE	M.S.A.	SK 1213-131	15-7710
B -	SUB-MANIFOLD VALVES (4)	B.A.C.	3-15692	15-7710
C -	PRESS. REDUCING VALVES (12)	B.A.C.	1-17289	15-7710
D -	OUTLET VALVES (19)	B.A.C.	1-17292	***
E -	REBREATHER, STRIPPED (10)	M.S.A.	SK 1213-44	***
F -	REBREATHER, WITH OXYGEN (5)	M.S.A.	SK 1213-43	***
G -	CYLINDER (NON-SHATTERABLE)	KIDDE	79139	15-7710
H -	SHUT-OFF VALVE	KIDDE	78933	15-7710

M.S.A. = MINES SAFETY APPLIANCE CO.

OUTLET VALVES (D)

1 - NOSE GUN STATION
2 - BOMBER'S STATION
3 - CO-PILOT'S STATION
4 - PILOT'S STATION
5 - COMM. OFFICER'S STATION
6 - RADIO OPERATOR'S STATION
7 - ENGINEER'S STATION
8 - NAVIGATOR'S STATION
9 - OFFICERS' QUARTERS
10 - GALLEY
11 - CREWS' QUARTERS
12 - LAVATORY AREA
13 - TOP GUN STATION
14 - SIDE GUN STATION
15 - TAIL GUN STATION

*** REFERENCE DWGS.

PLUMB. INST.	- HULL TAIL	15-7715
PLUMB. INST.	- HULL CENTER	15-7714
PLUMB. INST.	- M. DK. FWD.	15-7713
PLUMB. INST.	- FL. DECK	15-7712
PLUMB. INST.	- BOW	15-7710
PLUMB. INST.	- F. S. BLK.	15-7716
CYLINDER INST.		3-15231

with oxygen from a single cylinder or group of cylinders being fed to a main manifold with all nineteen outlets connected to the manifold. In the non-assisted takeoff condition, six 514 cubic inch shatterproof cylinders are installed in the bow compartment. In the assisted takeoff condition twelve cylinders may be installed.

Ten rebreather units are provided (government furnished), each of which may be connected to any outlet. Rebreather units provide a closed circuit for gas being breathed. A cannister in the circuit absorbs carbon dioxide and moisture exhaled from the lungs while a bladder operated valve supplies additional oxygen as it is needed.

Gunners are provided with a separate small oxygen supply attached to the turret rebreather unit. When the turret is being operated the main oxygen supply must be disconnected and oxygen is then supplied from the small cylinder on the rebreather unit.

m. ANCHOR GEAR

The anchor gear consists of a Danforth folding anchor, a two-speed, hand-operated winch, a tripod davit and a steel pendant cable spliced to the pendant ring on the bow keel fitting just below the bomber's window. In addition, a buoy hook, a boat hook and two 150-foot coils of ½ inch rope are stowed in the bow compartment and a 36 inch canvas bucket sea anchor is stowed in the waist compartment.

To use the Danforth anchor, first mount the davit out the port anchor door. This is done by inserting the key fitting leg into the slotted opening in the port anchor door step, turning it until the rear leg may be attached by the lock pin and lowering the davit out the door until the third leg fits into the socket below the doorway. The anchor may now be lowered out the doorway, the anchor cable placed in the sheave and guide and two retaining pins placed in the sheave bracket. The pendant clamp on the free end of the pendant cable should be fastened to the anchor cable when the desired length of cable has been run out, and lowered overboard to take the strain off the anchor winch and davit.

n. CREW BERTHS

Six berths are provided in the crew's quarters in two tiers of three each. The upper and lower berth of each tier are stationary, but the middle berth folds down to form a back rest during the day when crew members are sitting in the lower berths.

To prepare the berths for sitting, remove the retaining pins from the rods and cables supporting the middle berths, fold the rods flat against the lower berth, lower the middle berth, pull the lower braces from their receptacles in the wall and place a retaining pin through the berth and the brace so as to join them together to form a back rest.

o. REFRIGERATOR AND HOTPLATE

The refrigerator and hotplate are manually controlled in the galley. In addition, an emergency cut-off switch on top the engineer's switch panel allows the engineer to shut off the power to the galley refrigerator, hotplate and galley receptacle, and power to a receptacle in the officers' quarters. The emergency cut-off switch is to be used when the power used by the galley unit is needed for turret operation or other more important operations.

p. BILGE PUMP

A portable electric bilge pump and flexible hose is stowed on the right-hand side of the crew's compartment on the deck. To be used, the pump and hose may be transported to any compartment, assembled and the intake hose lowered into the bilge after removing the floor panels. The motor cord may be plugged into any convenient receptacle and the motor controlled by the receptacle switch. The capacity of the pump is 300 GPH of sea water.

q. NAVIGATOR'S HATCH

The navigator's hatch is operated by a rack and gear assembly at either side of the hatch. A hand crank and worm gear assembly drives the gears which extend the racks and force the hatch up or down. The racks are hinged at the upper end and when the hatch is closed the racks may be swung upward and secured in clips in the top of the cabin. To release the hinge in a rack pull downward on the ring at the lower end.

Access to the navigator's hatch is provided by a ladder which hooks over a tube mounted below the hatch. The lower end of the ladder rests against the navigator's table. The ladder is stowed in brackets by straps in the center of the upper portion of Bulkhead 364.

r. STOWAGE LOCKERS

Stowage lockers are provided in both the officers' and the crew's quarters. Two lockers are located above the bunks in the officers' quarters. In the crew's quarters, three lockers are attached to the right sidewall. In addition to the lockers, four slings are hung below the decks in the crew's quarters.

s. TARGET TOWING EQUIPMENT

Brackets are provided on the rear side of Bulkhead 771 for the installation of a target reel. In use, the towing cable extends from the reel aft over a permanently attached pulley on the forward side of Bulkhead 956 and down to a removable target mast mounted above the aft mooring hatch.

t. SUN SHADES

Sun shades are provided for covering the windows above the pilot's and co-pilot's heads. Curtains are made of sateen and are held in place by snap fasteners.

When stowed, the sun shades are rolled up and strapped in a single roll on the ceiling forward of the pilots' curtain.

u. BLACKOUT CURTAINS

Blackout curtains are provided for all windows in the airplane including the partition window between the flight deck and bow compartment. Curtains are made of flame-proofed sateen, held in place by snap fasteners.

All flight deck blackout curtains are rolled up with the pilots' sun shades when not in use. The bomber's blackout curtains are rolled up and stowed beside the bomber's window. The curtains for the windows in the galley and in the officers' quarters are to be rolled up in the curtains on the main access doors in the crew's quarters, two to each curtain. Each of the remaining curtains is to be rolled and strapped above its respective window.

v. BOMBER'S WINDOW COVER

During take-off and landing, the bomber's window should be shielded from the inside by the hinged metal cover held in place and made watertight by dogs.

When stowed, the cover is held in place on the ceiling of the bow compartment, under the floor of the flight deck, with one side held in brackets on Bulkhead 150 and the other side held to the flight deck structure by clips.

Section V

POWER PLANT

1. ENGINE TYPE AND RATING

a. ENGINES

Wright Duplex Cyclone, 18 cylinder, Model XR-3350-8, two-speed supercharged, geared 16:7.

Rating—(Manufacturer's estimate)

	BHP	RPM	BLOWER	ALTITUDE
NORMAL	2000	2400	LOW	S.L.—5,700
	1800	2400	HIGH	
TAKE-OFF	2200	2600	LOW	

Fuel—100 Octane, AN Spec. AN-VV-F-781

Oil—Grade 1120, AN Spec. AN-VV-O-446 (Recommended grade varies with operating conditions, see T.O. 24-41)

Maximum Driving RPM—2880

b. PROPELLERS

Curtiss Electric, constant speed, controllable pitch, three blade, 16′-6″ diameter propellers are installed on this airplane.

ENGINE OPERATING CHART

OPERATING CONDITION	BHP	RPM	MAX. M. P. (IN. HG)
Takeoff (S.L.)	2200	2600	46
Normal Rated	2000	2400	40
Maximum Cruising	1300	2080	31.2
Desired Cruising	1200	2025	29.7
Desired Cruising	1100	1970	28.2

ALTITUDE (FEET)	SUPERCHARGER CLUTCH CONTROL POSITION
S.L.	Low Ratio
12,800	Low Ratio
5,700	Low Ratio
13,900	Low Ratio
15,300	Low Ratio

MIXTURE CONTROL POSITION	MAX. CYL. HEAD TEMP. (°C.)	MAX. CYL. BASE TEMP. (°C.)
Auto Rich	260	163*
Auto Rich	248**	163**
Auto Rich	232	163
Auto Rich	218	163
Auto Lean	205	163

* Five minutes operation only

** Normal rated power to 90% normal rated power, one hour operation only

Maximum engine overspeed: 2880 RPM

Fuel Grade: 100 octane, Specification AN-VV-F-781

Oil Grade: 1120, Specification AN-VV-0-446 (Recommended grade dependent upon operating conditions. See Bu Aero. Tech. Note No. 24-41.)

2. ENGINE OPERATION

a. PRE-STARTING PROCEDURE

(1) Start and warm up the auxiliary power plant as per instructions in Section IV, 3, *c.* Turn the auxiliary power plant generator on and check voltage and charging rate.

(2) To clear combustion chambers: With the throttle full OPEN and the ignition OFF, adjust the starter switch to START. When the starter reaches one-fourth maximum speed, mesh the starter while holding the booster cutoff switch in the OFF position. The propeller should make at least *three* revolutions. If the propeller stops suddenly or seems to turn exceptionally hard, remove the spark plugs from the lower cylinders to determine whether liquid has collected there.

CAUTION: The presence of liquid in any of the cylinders is likely to cause serious damage if the engine fires.
In extremely cold weather, if the temperature of the oil is less than 20° F. (-7°C.) the engine should be pre-heated prior to starting. For engine pre-heating, a canvas hood is placed over the engine and canvas heater ducts are attached from the cabin heater duct in the crew's compartment to the canvas hood on the engine. (See Figure 20). Operate the cabin heater from the Engineer's station. See Section IV, 3.

(3) Open the cowl flaps, close the oil cooler door and place the oil cooler door switch on AUTO.

(4) Adjust the carburetor air controls to DIRECT.

(5) Adjust the supercharger controls to LOW and be sure they are locked.

(6) Adjust the mixture controls to IDLE CUTOFF.

(7) Adjust the throttle controls to obtain 1000 RPM when the engine starts.

(8) Turn the propeller master unit ON and adjust the RPM to 2600.

(9) Adjust the propeller to low pitch and leave the switch in AUTO.

(10) Set the fire extinguisher selector valve to the engine being started.

b. START

(1) Adjust both tank selector valves to main tank.

(2) Turn auxiliary fuel pump ON.

(3) Prime five seconds or as necessary (determine by experiment—a warm engine may need no priming).

CAUTION: Do not prime the engine by pouring raw gasoline into the cylinders through exhaust ports or spark plug bushings. Do not overprime. Overpriming may prevent any firing taking place or may result in only a few explosions, torching and white fog from the exhaust stacks. If the engine becomes overprimed, turn the ignition OFF, open the throttle, and turn the engine over several revolutions until it has cleared out. When cleared, return the throttle to the 1000 RPM position. Do not attempt to prime the engine by moving the throttle as a lean mixture and backfire hazard will result.

(4) Adjust ignition switch to BOTH and master switch IN.

(5) Hold starter switch on until engine starts. Limit operation to ONE minute. Allow at least one minute for cooling.

(6) If engine does not start after two or three turns of the propeller, prime by moving the mixture control to AUTO. RICH for approximately one-half turn of the propeller, then return the control to IDLE CUTOFF. As soon as the engine starts to fire, move the mixture control to AUTO. RICH.

(7) If engine does not start after 3 attempts allow the starter to cool for 5 minutes before repeating the above procedure.

(8) If necessary operate the primer intermittently after starting until the fuel pressure builds up. (15 to 19 PSI.)

(9) If oil pressure does not reach 40 PSI in ten seconds after starting, stop the engine with the mixture control and investigate.

c. WARM-UP

(1) Run the engine at 1000 RPM until the oil inlet temperature reaches 60°C. or at least until an oil temperature rise of 10°C. is attained.

(2) Watch the oil pressure gauge for fluctuation in pressure caused by air trapped in the oil lines. Any air so trapped should be allowed to escape by extending the warm-up period until the oil pressure stabilizes.

(3) The engine cowl flaps must be open. Closing the cowl flaps will *not* shorten the warm-up period and may result in cracking the cylinder fins because of the difference in temperature between the

forward and rearward portions of the fins. Closing the cowl flaps may also result in burning the ignition system ignition.

d. PERFORMANCE CHECK

(1) After the engine has been given a thorough warm-up, open the throttle to not more than 30″ Hg. manifold pressure and with an engine speed not in excess of 2000 RPM, check the pressures of the fuel and oil, the temperature of the oil and performances of the magnetos.

CONDITION	FUEL PRESSURE LB/SQ. IN.	OIL PRESSURE LB/SQ. IN.	OIL INLET TEMP. (°C.)
Desired	17	75	70
Maximum	19	80	85
Minimum	15	70	----
Idling	----	25	----

(2) If the oil pressure drops when the throttle is opened the warm-up has been insufficient in duration and should be continued at 1200 RPM.

(3) Before starting the magneto check, always have the propeller in low pitch and the propeller selector switch in the OFF, or fixed pitch, position so that any drop in engine RPM will not be compensated for by the propeller. Check the magneto performance by operating the engines on one breaker assembly at a time. When operating the engines on one breaker assembly the engine speed should not drop more than 75 RPM from the speed obtained when both breakers are being used. A drop of RPM in excess of this value indicates improper functioning of the breaker assembly or misfiring of one or more of the cylinders due to a malfunctioning spark plug. Make the checks in as short a time as practical since continued running on one switch point may cause serious detonation.

e. TAKE-OFF

(1) It is not advisable to take-off with cylinder head temperatures below 121°C. The maximum cylinder head temperature immediately before take-off must be determined by experience to permit a normal take-off and climb without exceeding the maximum temperature limit. (260°C.)

(2) Adjust mixture control to AUTO. RICH.

(3) Adjust propeller master unit to 2550 RPM.

(4) Adjust propeller selector switch to AUTO.

(5) Set the cowl flaps in the normal position for take-off.

(6) Open the throttle slowly to 46″ Hg. manifold pressure. Do not operate at this condition for more than five minutes.

(7) Check cylinder head temperatures carefully. Do not exceed 260°C. during take-off (5 minutes only)..

f. NORMAL RATED (100%) POWER CLIMB & LEVEL FLIGHT

(1) Turn auxiliary fuel pumps OFF.

(2) Regulate the manifold pressure in accordance with Table I.

(3) Adjust propeller master unit for 2400 RPM.

(4) Adjust mixture control to AUTO. RICH.

(5) Do not exceed the maximum specified cylinder head temperature for the operating condition (248°C., one hour only; 232° C., continuous operation.)

TABLE I

*Normal Rated (100%) Power (2400 RPM)

Altitude (Feet)	Max. Manifold Pressure (In. Hg.)
Sea Level	42.5
1000	42.0
2000	41.5
3000	41.0
4000	40.7
5000	40.3
5700	40.0
Above 5700	Use Full Throttle

g. *MAXIMUM CRUISING (65%) POWER CLIMB AND LEVEL FLIGHT.

(1) Regulate the manifold pressure in accordance with Table II.

(2) Adjust propeller master unit for 2080 RPM.

(3) Adjust mixture control to AUTO. LEAN (Enrich manually, if necessary, to maintain cylinder head temperatures within allowable limits.)

(4) Do not exceed the maximum specified cylinder head operating temperature for the operating condition (218°C.).

TABLE II

*Maximum Cruising (65%) Power (2080 RPM)

Altitude (Feet)	Max. Manifold Pressure (In. Hg.)
Sea Level	31.2
2000	30.5
4000	30.0
6000	29.5
8000	29.0
10000	28.5
12800	28.0
Above 12800	Use Full Throttle

* See Special Precautions, Sec. VII, 4.

h. DIVING

(1) Adjust mixture control to AUTO. RICH.

(2) Set throttle so that a manifold pressure of 20" Hg. will not be exceeded.

(3) Never exceed the maximum diving speed of 2880 RPM.

(4) Close cowl flaps enough to prevent excessive cooling.

i. LANDING

(1) Adjust mixture control to AUTO. RICH.

(2) Adjust propeller master unit to 2400 RPM.

(3) Set the cowl flaps so as to maintain suitable operating temperatures.

(4) After landing, open the cowl flaps.

j. STOPPING ENGINES

(1) Set the cowl flaps to the full OPEN position.

(2) With the engine controls set as in landing, idle the engine at 600 to 800 RPM until the cylinder head temperatures drop below 149°C.

(3) Increase the engine speed to 1000 to 1200 RPM and hold for one-half minute to obtain optimum scavenging of oil from the engine before shutting down. Move the mixture control to the IDLE CUTOFF position.

(4) After propeller stops turning, turn the ignition switch OFF.

(5) Turn fuel tank selector valve OFF.

k. MIXTURE CONTROL

The mixture control on the Stromberg PR58-A1 carburetor has four definite positions; namely, AUTOMATIC RICH, FULL RICH, AUTOMATIC LEAN and IDLE CUTOFF. Fuel will flow with the mixture control in any position except IDLE CUTOFF whenever the fuel pressure is greater than 5 PSI, whether the engine is running or stopped. Therefore, when the engine is idle, the mixture control should be left in the IDLE CUTOFF position in order to prevent fuel from collecting in the diffuser section and running out the drain.

If operating under cruising conditions with the mixture control in the AUTO. LEAN position, move the mixture control to the AUTO. RICH position before changing engine power. Excessive leaning of the mixture is generally accompanied by a rise in cylinder head temperatures. Use caution to prevent exceeding the maximum permissible cylinder head temperatures when using the mixture controls.

l. USE OF PROPELLER MASTER SYNCHRONIZER CONTROL

Engine RPM should be set by the propeller master synchronizer control, and manifold pressure set by the throttle. When increasing power, set the desired RPM first with the synchronizer control, and then adjust the throttle to obtain the desired manifold pressure. When decreasing power, set the desired manifold pressure first with the throttle control and then set the propeller synchronizer control to the desired RPM.

m. OPERATION OF TWO-SPEED SUPERCHARGER (See BuAero Technical Note No. 87-42)

With the present engines as installed for the airplane tests, the superchargers consist only of single speed, low blower operation with the controls inoperative, but in the event two speed superchargers are eventually installed, the following instructions will apply:

Changes from one supercharger ratio to another should be made quickly without pausing in neutral. The supercharger control must be locked at the extremity of its travel in either ratio to insure complete engagement of the clutch.

Supercharger ratio shifts should not be made at intervals of less than five minutes. The interval provides time for dissipation of the heat generated during clutch engagement.

When shifting from low to high supercharger, carefully observe the following sequence:

(1) Set the mixture control in AUTO. RICH position.

(2) Partially close throttle so that the desired high supercharger manifold pressure will not be exceeded. (The amount of closing to give desired manifold pressure, or less, *after* the shift has been made will be determined by experience.)

(3) Move the supercharger control rapidly from LOW position to HIGH position and lock.

(4) Re-adjust throttle setting if manifold pressure is not at the desired value for high supercharger operation.

(5) Re-adjust RPM setting only as necessary to obtain desired power.

When shifting from HIGH to LOW supercharger, operate the two-speed supercharger control in the following manner:

(1) Quickly move the supercharger control to the LOW position and lock before moving throttle.

(2) Set the desired manifold pressure with the throttle.

(3) Re-adjust the RPM setting only as necessary to obtain desired power.

For an operation check of the supercharger, proceed as follows:

Set the propeller in full low pitch (high RPM) position. Open the throttle to 1700 RPM, move the supercharger control lever to the HIGH position and lock. Open the throttle to obtain not over 30″ Hg. MP. When the engine speed has become stabilized, observe the manifold pressure and immediately shift the supercharger control to the LOW position without moving the throttle. A sudden decrease in manifold pressure is an indication that the two-speed supercharger drive is operating properly.

n. COWL FLAPS OPERATION

Cylinder head temperatures should be maintained within the following limits:

Take-off, maximum allowable for 5 minutes....248°C.

Normal rated power, maximum, one hour........232°C.

Continuous, maximum allowable........................218°C.

Cruising, recommended maximum....................205°C.

For take-off, flaps should be at the optimum cooling position which is silghtly less than full OPEN and presents less drag. In flight, flaps should be adjusted to provide proper engine cooling.

Flaps are operated by a reversible electric motor with a control switch on the engineer's switch panel. *Hold* the switch up to open the flaps and down to close. Limit switches in the motor assembly stop the motor at full open and completely closed positions of the flaps.

3. CARBURETOR AIR CONTROL

The carburetors used on this airplane are non-icing Stromberg Model PR58-A1 and little difficulty should be experienced due to icing within the carburetor. However, under severe icing conditions when the control is on DIRECT, ice may form on the vanes in the air duct or on the carburetor screen. When the control is on DIRECT air is being taken by ram direct from the air scoop in the nose of the cowl. Under severe icing conditions, such as heavy rain, sleet, or snow, the control should be adjusted to ALTERNATE.

In the ALTERNATE position warm air is taken from a protected source near the exhaust manifold, but baffled from direct contact with the manifold.

The control is adjustable to either extreme position with no provision for intermediate positions. No attempt should be made to regulate air temperature by leaving the control in an intermediate position. See BuAer T.O. No. 44-40.

The carburetor air supply should be adjusted to DIRECT for all conditions except heavy precipitation or other bad icing conditions, or accidental clogging of the direct air intake, in such cases the ALTERNATE position should be used. See BuAero Tech. Note No. 36-41.

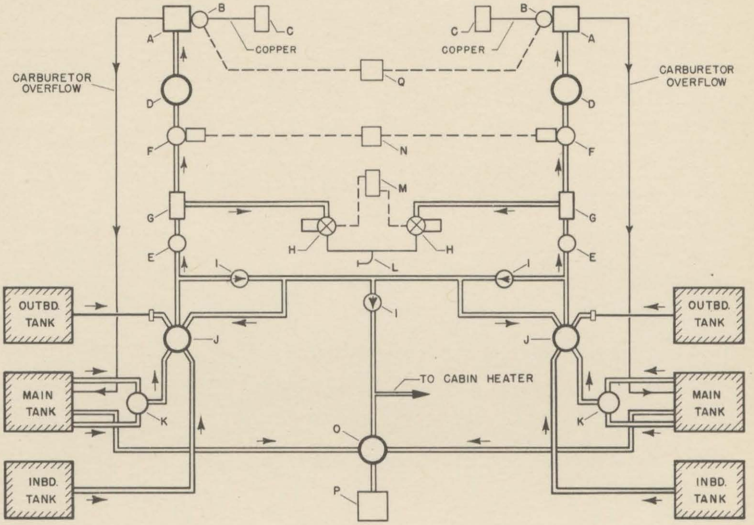
Changing to the alternate air supply will result in a small decrease in power due to loss of ram and decreased density of the warm air from the protected source. A slight readjustment of throttle may be necessary.

The carburetor air temperature bulb is located in the side of the upper vertical part of the duct aft of the carburetor. The indicator is on the engineer's instrument panel.

4. FUEL SYSTEM—See Figure 23

a. TANKS

The fuel tanks are constructed as gasoline-tight sections between the wing spars. The inboard tanks are part of the wing center section. Each tank extends from the centerline outboard to Station 39. The main and outboard tanks are in the outer wing panels extending from Stations 271 to 381 and from Stations 381 to 579 respectively. The webs of the ribs included in each tank are provided with holes so that gasoline may flow through. Thus, these ribs act as baffles in each tank.



LEGEND

A- CARBURETOR
B- SOLENOID PRIMER VALVE
C- ENG. PRIMER MANIFOLD
D- FUEL PUMP
E- FUEL FLOWMETER TRANSM.
F- ELECT. FUEL PUMP
G- FUEL STRAINER
H- STRAINER DRAIN VALVE
I- SWING CHECK VALVE
J- TANK SELECTOR VALVE
K- SOLENOID SELECTOR VALVE
L- OVERBOARD DRAIN
M- STRAINER DRAIN SWITCH
N- FUEL PUMP SWITCH
O- TANK SELECTOR VALVE (AUX. P.P.)
P- AUX. POWER PLANT
Q- ENG. PRIMER SWITCH

TANK CAPACITIES
IN U.S. GALS.

TANK	VOL.	MAX. LOADING
INBOARD	1420	1250
MAIN	1565	1565
OUTBOARD	1732	1710
		4525
TOTAL 6 TANKS		9050

ALL DOUBLE LINES ARE SELF-SEALING HOSE. — NAVY SPEC. M 497-B

NOTE:
SEE FUEL SYSTEM DIAGRAM FOR TUBING.
SEE ENGINEER'S SWITCH PANEL FOR SWITCHES.

FIG. 24 FUEL SYSTEM FLOW DIAGRAM 15-6910

30178
1243-F

EMPTY TANKS IN THE FOLLOWING ORDER:
1. INBOARD AUXILIARY TANKS
2. OUTBOARD AUXILIARY TANKS
3. MAIN TANKS

CAUTION

BEFORE USING AUXILIARY TANKS, USE SUFFICIENT FUEL FROM MAIN TANKS TO ALLOW FOR CARBURETOR OVERFLOW. (APPROX. 4 QTS. PER HOUR - SEE TEXT)

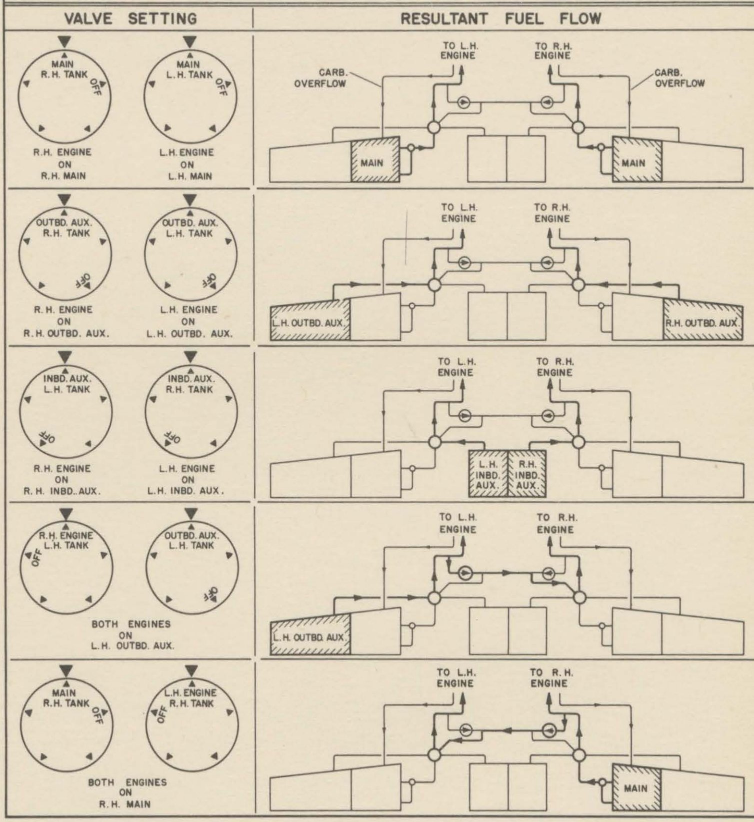


FIG. 25 FUEL TANK SELECTOR VALVE SETTINGS-TYPICAL

Fuel tank capacities in U.S. gallons are as follows:

	Vol.	*Max. Loading*
L.H. Main	1565	1565
R.H. Main	1565	1565
L.H. Outboard	1732	1710
R.H. Outboard	1732	1710
L.H. Inboard	1420	1250
R.H. Inboard	1420	1250
Total		9050

The inboard auxiliary tank and outboard auxiliary tank may be completely emptied in level flight only. During a climb or glide, when the fuel is low in the inboard and outboard auxiliary tanks, the engines should be operated from the main tanks. This avoids an apparent exhaustion of fuel occuring when the outlets in the auxiliary tanks are above the full level.

The two main outlets in each of the main fuel tanks are connected to a sump selector valve controlled by a mercury switch through a time delay relay. Attitude of the airplane in a climb or glide causes the mercury switch to select the lowest tank outlet for the fuel flow.

Operation of the selector valve may be ground checked by loosening the Dzus fasteners and tipping the entire support and box forward to operate the mercury switch. An audible "click" may be heard from a point near the valve when the valve operates.

CAUTION: Each time the adjustment between the box and support is disturbed, the adjustment must be carefully set and checked before the next airplane flight.

When refueling on water fill both main tanks at as nearly the same rate as possible. Do not allow a difference of more than one half of one tank to exist between the two tanks at any time.

A reserve of 25 gallons of fuel for the auxiliary power plant is retained in the main tanks by providing standpipes at the main

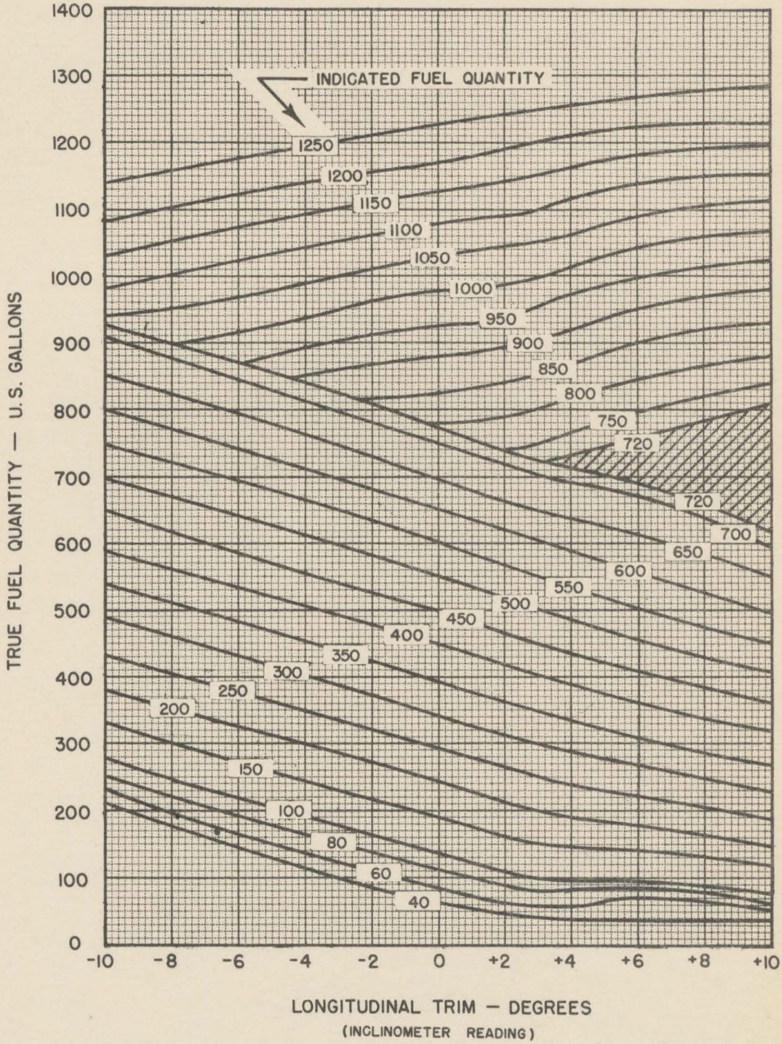


FIG. 26 TRIM CORRECTION CURVES - INBD. AUX. FUEL TANK GAGE

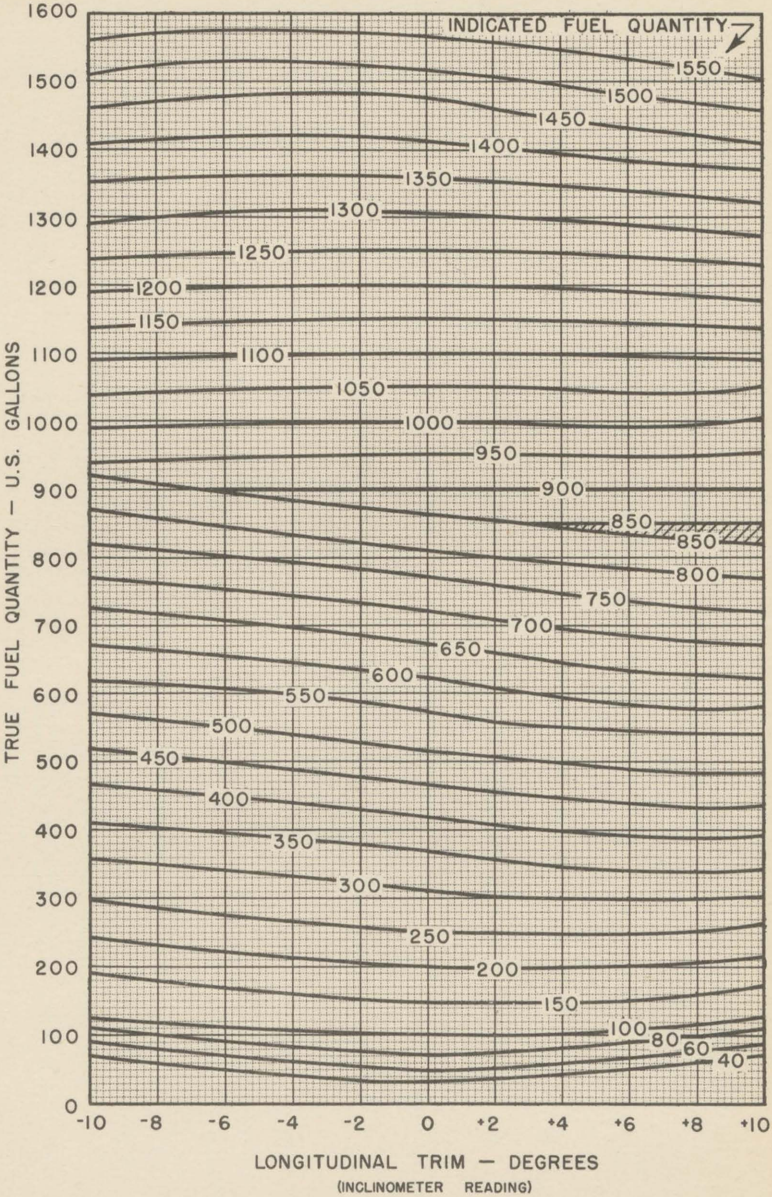


FIG. 27 TRIM CORRECTION CURVES - MAIN FUEL TANK GAGE

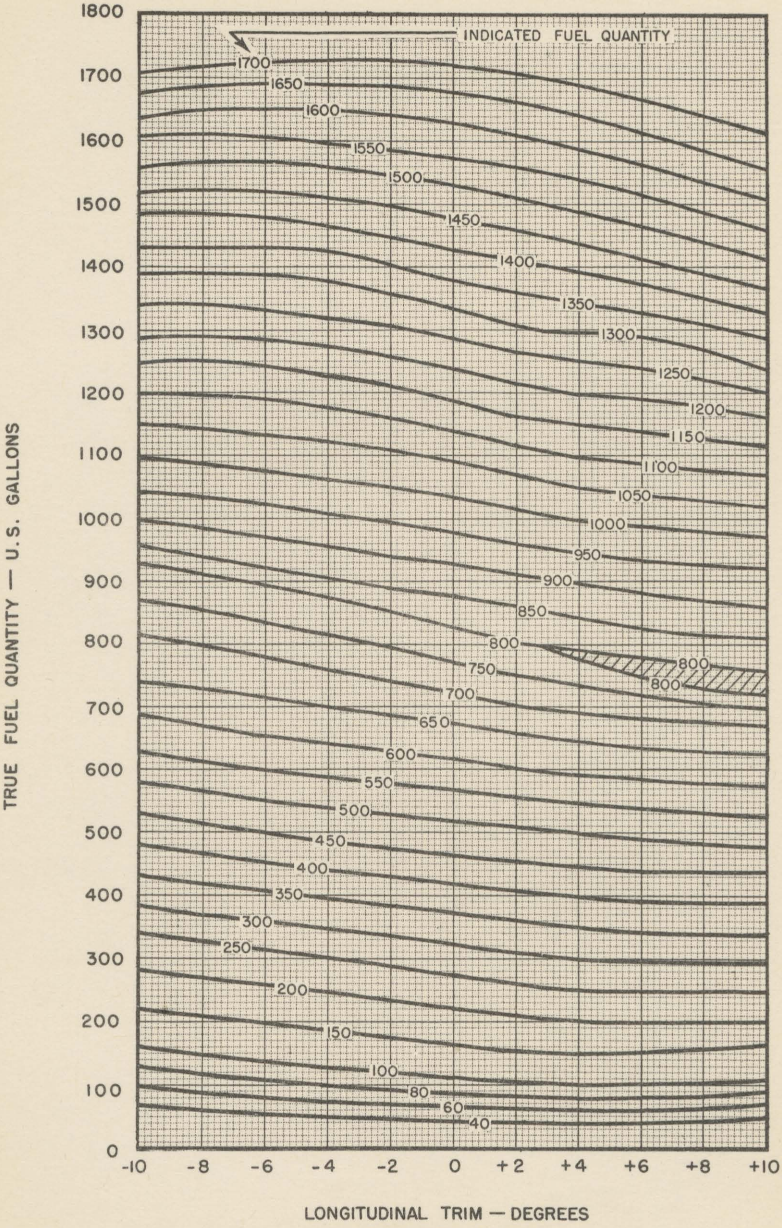


FIG. 28 TRIM CORRECTION CURVES—OUTBD. AUX. FUEL TANK GAGE

outlets high enough to save twelve and one-half gallons of fuel in each tank. A separate outlet in the bottom of each main tank leads to the selector valve for the auxiliary power plant where fuel may be taken from the cross feed line or from the reserve in either main tank. During normal operation, fuel for the auxiliary power plant should always be taken from the cross-supply line so that the twelve and one-half gallon reserve supply will be left for emergency operation of the auxiliary power plant.

b. FUEL DUMP VALVES

(1) Description

The main and outboard auxiliary tanks are equipped with fuel dump valves for quickly reducing the load to the maximum gross weight allowed for landing. The valves are of the swing gate type and are connected directly to a tail pipe which swings down normal to the wing surface, guiding the dumped fuel away from the wing flaps and tail surfaces. The controls for the dump valves are located at the engineer's station behind a panel on Bulkhead 364. Each valve is so arranged that the tail pipe is partially lowered into dumping position before the valve opens to allow fuel to flow from the tanks. The tailpipe may be retracted and the valve closed after sufficient fuel has been dumped, even though fuel still remains in the tank.

The linkage at the valve and tailpipe is arranged so that dead center positions are attained for both in the retracted position. This reduces cable loads and guards against accidental opening of the valve in ase of cable failure.

(2) Operation

(*a*) To Dump Fuel:

(1) Pull control lever all the way up (tailpipe extends and valve opens).

(*b*) To Close Dump Valve:

(1) Push control lever half way so that tail pipe retracts to an angle of approximately 45° from vertical (valve closes at 30°).

(2) Allow tail pipe to drain completely (30 to 45 seconds required).

(3) Raise tail pipe to the up position, using a firm downward stroke on the lever and slamming the tail pipe in place.

CAUTION: The fuel should not be dumped when the flap angle exceeds 15°. The proper attitude of the airplane when fuel is being dumped is ½° nose up. In this position enough fuel will be trapped in the main tanks for emergency use of the auxiliary power plant. A higher rate of climb will trap insufficient fuel while a lesser rate of climb will trap too much. When main and outboard tanks are jettisoned, leaving inboard tanks full, the restricted speed is 190 Knots (219 mph).

c. VAPOR DILUTION

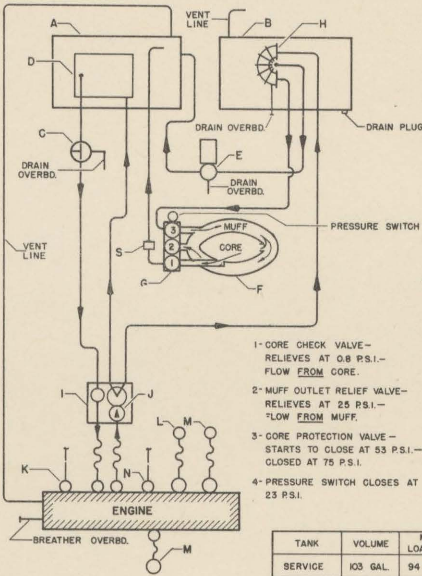
A vapor dilution system has been provided in the outboard auxiliary tanks to be used after dumping the fuel to disperse the gasoline vapors. One 20 pound bottle of CO_2 is provided for vapor dilution of each of the outboard auxiliary tanks. The controls are located at the engineer's station. Do not attempt to use the vapor dilution system until the tanks are empty or nearly so, for the effect of the CO_2 would soon be nullified by further emptying of the tanks. Outboard auxiliary dump valves must be closed before using the vapor dilution system for that tank.

d. FUEL SYSTEM OPERATION

The tank selector valves, one in each nacelle, are cable controlled from the engineer's station. There are ports on each valve allowing the engine on that side of the airplane to be fed from any of the three tanks on that side. In addition to these three ports, a cross-supply port is provided allowing both engines to be fed from a single tank. When either of the selector valves is adjusted to "cross-supply," the other valve is automatically kept from the same position. A cam and sliding pin lock assembly on the valve control prevents both valves being adjusted to "cross-supply" at the same time which would shut off the fuel supply to both engines.

The independent fuel supply system in each nacelle consists of an electric flowmeter, a strainer, an electric fuel pump and an engine-driven fuel pump. The fuel strainers are connected by drain lines to solenoid valves near the bottom of the hull so that they may be emptied of water or sediment during flight. The strainer should be drained immediately after take-off and before landing to avoid danger of water freezing in the lines. The strainer drain switch is a momentary type and is located on the engineer's switch panel. The electric fuel pump is used in starting, as an emergency unit in case of engine pump failure or for fuel boost at high altitude. The control switch is located at the engineer's station. When starting the engines and until they are running smoothly, the electric auxiliary fuel pumps must be used to obtain fuel pressure for priming and carburetion.

The engine primers consist of solenoid valves on the carburetors and are controlled by momentary switches at the engineer's station.

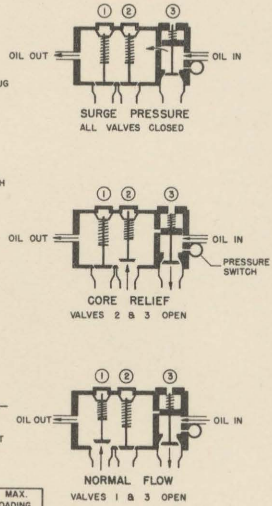


1- CORE CHECK VALVE- RELIEVES AT 0.8 P.S.I.- FLOW FROM CORE.

2- MUFF OUTLET RELIEF VALVE- RELIEVES AT 25 P.S.I.- FLOW FROM MUFF.

3- CORE PROTECTION VALVE - STARTS TO CLOSE AT 53 P.S.I.- CLOSED AT 75 P.S.I.

4- PRESSURE SWITCH CLOSES AT 23 P.S.I.

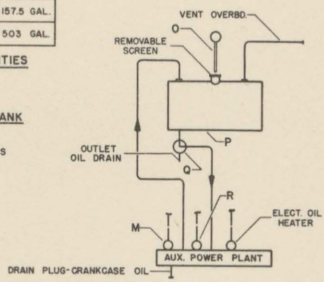


TANK	VOLUME	MAX. LOADING
SERVICE	103 GAL.	94 GAL.
STORAGE	167 GAL.	157.5 GAL.
TOTAL 4 TANKS	540 GAL.	503 GAL.

OIL TANK CAPACITIES

AUXILIARY ENGINE OIL TANK

6 GALLONS GROSS —
4 GALLONS OIL + 2 GALLONS EXPANSION SPACE.



LEGEND

A- SERVICE OIL TANK
B- STORAGE OIL TANK
C- DRAIN & SHUT-OFF VALVE
D- HOPPER
E- ELECTRIC PUMP
F- OIL COOLER
G- OIL COOLER OUTLET VALVE
H- HEAT EXCHANGER
I- AUTO. TEMP. CONTROL VALVE
J- CHECK VALVE IN AUTO. TEMP. CONTROL VALVE
K- ELECTRIC OIL-IN TEMP. BULB
L- HORSEPOWER TRANSMITTER
M- OIL PRESSURE TRANSMITTER
N- ELECTRIC OIL-OUT TEMP. BULB
O- STICK TYPE GAGE
P- AUX. POWER PLANT OIL TANK
Q- DRAIN VALVE
R- ELECTRIC OIL TEMP. BULB
S- THERMOSTAT

FIG. 29 OIL SYSTEM FLOW DIAGRAM 15-6915

30177
1279-G

IMPORTANT: Installation of a vapor vent line from carburetor to main tank results in a slight transfer of fuel when other than main tanks are being used. Fuel returned by this means may amount to five to seven gallons per hour. However, if a carburetor using float type vapor separator is installed, this transfer will be reduced to four quarts per hour or less. Although main tanks are to be emptied last, enough fuel should be used from main tanks first to provide room for overflow from auxiliaries. On extended flights transfer of fuel results in an apparent increase of fuel consumption while using auxiliary tanks.

5. OIL SYSTEM—See Figure 28

An individual oil system for each engine includes the oil service tank, oil storage tank, automatic temperature control valve, oil cooler with automatic pressure control valve and electric pump for delivering oil from storage tank to service tank.

The oil tanks are integral with the wing center section and occupy a section between front and rear spars from wing Station 155 to 172 on each side. This section is directly aft of the nacelle. The service tank is the front part of each section; the storage tank is the rear part.

Tank capacities in U.S. gallons are as follows:

	Volume	*Maximum Load*
Service, L.H.	103	94
Storage, L.H.	167	157.5
Service, R.H.	103	94
Storage, R.H.	167	157.5
Total		503.0

The service tank outlet is in a hopper. From the outlet, oil flows through the sylphon compartment of the automatic temperature control valve to the engine. The sylphon actuates the valve according to the temperature of the oil passing through. When the oil is cold, the valve returns oil from the engine directly to the warm-up hopper in the service tank. When oil flowing to the engine reaches 130°F., the valve begins to divert oil from the engine to the cooler circuit. At 150°F. all the oil is flowing through the cooler circuit. The oil line before reaching the cooler passes through the heater in the oil storage tank. The heat from the circulating oil warms the storage oil at the transfer pump inlet enough to allow easy flow of oil through the transfer pump. The electrically-driven transfer pump delivers oil from the storage tank to the service tank. The control switch is on the engineer's panel. The transfer pump is only slightly larger than required to replace oil as consumed by the engine.

From the oil heater, oil flows to the oil cooler in the bottom of the nacelle. There is no temperature regulating element within the oil cooler; however, an automatic and manually controlled and electrically-operated cooling air exit door provides regulation of air flow. Control of this door should normally be automatic by adjusting the switch on the engineer's panel to AUTO., but if manual control is necessary the door should be kept in the most nearly closed position that will provide sufficient cooling. Any excessive opening causes the oil temperature regulator to by-pass a portion of the oil directly to the tank with consequent excessive cooling drag.

Section VI

OPERATION CHARTS AND DATA

1. ENGINE FLIGHT CALIBRATION CHART—See Figure 29

a. PURPOSE

To find actual horsepower when given pressure altitude, RPM, manifold pressure, and free air temperature:

(1) Locate position "A" on altitude curve for given RPM and manifold pressure.

(2) Locate "B" on sea level performance curve for same RPM and manifold pressure. Transfer position to "C."

(3) Draw straight line from "C" through "A" and read horsepower at observed density altitude of flight (point "D" in example).

(4) Correct horsepower in accordance with free air temperature by applying the following:

(a) Add 1% for each 6°C. decrease from Ts.

(b) Subtract 1% for each 6°C. increase from Ts.
(Ts—Standard Altitude Temperature)

b. EXAMPLE

Pressure Altitude—5000′

RPM—1900

Manifold Pressure—30″ Hg.

O.A.T.—17°C.

(1) Locate 1900 RPM and 30″ M.P. on altitude curve.

(2) On sea level perform curve, locate 1900 RPM and 30″ M.P. (point "B"). Read across to sea level on altitude curve (point "C").

(3) Draw a straight line from "C" to "A" and read—horsepower 1210 at 5000′ pressure altitude.

(4) Temperature at 17°C. is 12° above standard. Subtract 2% power (24 B.H.P.) to obtain correct horsepower. Correct H.P. is 1210-24=1186.

2. FLIGHT OPERATIONS CHARTS

a. PURPOSE

Use these charts to determine range, operating conditions, and average airspeed.

(1) Allow 50 gal. fuel for warm-up and takeoff. Find the amount of fuel necessary for the climb to altitude from the Climb Chart on the Fuel Consumption Chart (Fig. 32).

(2) Enter the Range Chart (Fig. 30) at gallons of fuel

30560
2998

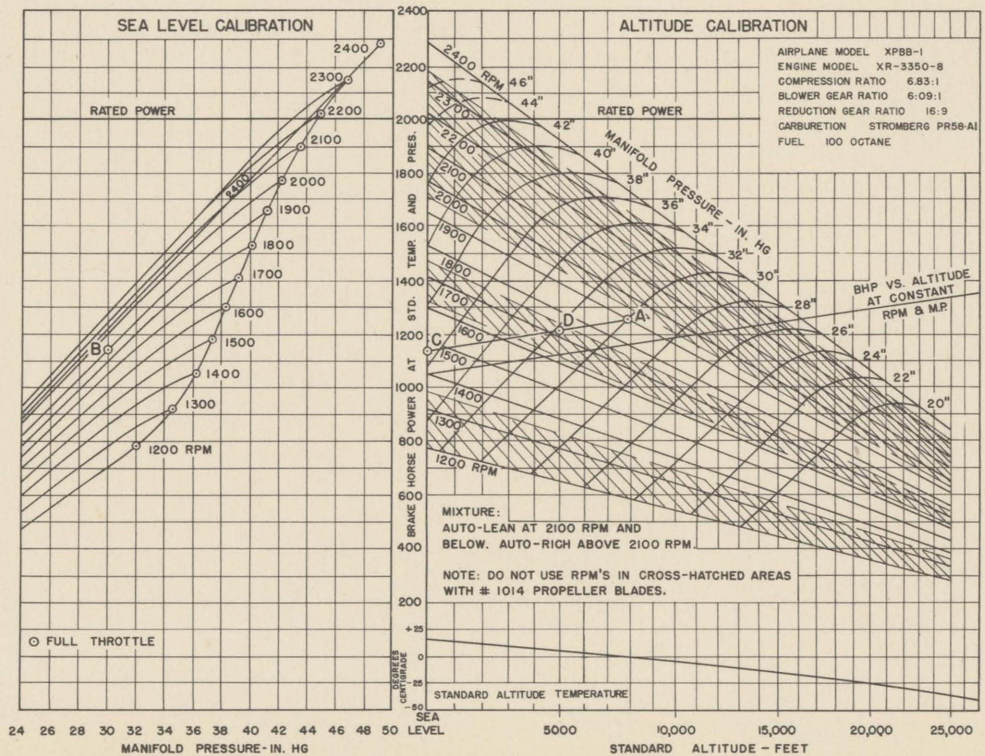


FIG. 30 ENGINE FLIGHT CALIBRATION CHART

available and go to column containing the range desired. Read the letter at the top of this column opposite the headwind condition.

(3) Note weight of airplane and enter Operations Chart (Fig. 31). The desired range can be accomplished by operating with the power condition indicated wherever the range letter appears. If the desired range letter does not appear, use the next higher letter appearing (if operation is between "A" and "M"). Note that between "A" and "M," the higher the letter the greater the range.

(4) Engine operation necessary to achieve the spcified results is indicated at the top of each column of the Operation Chart.

(5) An "X" in the blank spaces on Operation Chart indicates the power condition is not satisfactory for flight at that specified weight and altitude.

b. EXAMPLE

Range desired—1700 Nautical Miles
Fuel—2310 Gallons
Flight Altitude—5000′
Average weight at approximately 60,000 pounds
No headwind

From climb chart (see Fuel Consumption Chart, Fig. 32) find 56 gallons required for climb. Allow 50 gallons for warmup and take-off. The fuel available for flight is thus 2205 gallons. Enter range chart at 2200 gallons and find a range of 1760 nautical miles under condition "K." On the operation chart opposite the average weight and 5000 feet, condition "K" appears under maximum recommended power—1900 RPM and 140 BMEP. Average true airspeed should be 142 knots. This is the maximum speed and power at which mission can be completed. If greater reserve is desired, fly at condition "L."

3. CRUISING CONTROL AND FUEL CONSUMPTION CHARTS—See Figs. 32-35

Although both cruising control and fuel consumption charts are provided, their use is optional, since the Range and Operations Charts cover the same information in a more quickly readable form.

Cruising control charts are provided for sea level, 5000 foot and 10,000 foot altitudes with B.H.P. per engine and fuel consumption nautical miles per gallon plotted against the true airspeed for various load conditions and propeller RPM's.

Note that certain conditions should *not* be attempted with the No. 1014 propellers now in service.

FIG. 31 RANGE CHART

NO HEADWIND	A	B	C	D	E		K	L	M	R	S	
Headwind 10% of T.A.S.	B	C	D	E			L	M				
Headwind 20% of T.A.S.	C	D	E				M					
Headwind 30% of T.A.S.	D	E										
Headwind 40% of T.A.S.	E											
FUEL AVAILABLE - GALLONS												**FUEL AVAILABLE - GALLONS**
200	60	70	70	80	85	Conditions between E and K cannot be obtained with #1014 propeller blades. If E does not give desired range, go to K, L, M, R or S.	155	165	190	80	145	200
400	120	140	145	155	175		310	320	370	190	285	400
600	180	200	215	235	260		460	485	545	295	415	600
800	240	270	295	310	350		625	660	740	415	575	800
1000	305	340	365	400	435		780	835	930	555	720	1000
1200	365	405	435	475	530		945	1010	1120	695	870	1200
1400	425	470	510	555	615		1110	1180	1300	850	1025	1400
1600	495	540	580	640	710		1270	1370	1500	1010	1180	1600
1800	555	610	660	730	800		1430	1550	1700	1165	1340	1800
2000	615	675	740	810	895		1600	1730	1900	1330	1495	2000
2200	675	745	815	895	990		1760	1910		1490	1660	2200
2400	745	815	895	980	1085		1910	2090		1650	1820	2400
2600	810	885	965	1060	1180		2075	2265		1820	1995	2600
2800	870	955	1040	1145	1270		2240	2450		1995	2170	2800
3000	930	1025	1120	1230	1365		2405	2630		2170	2340	3000
3200	1000	1095	1200	1320	1460		2580	2810		2340	2520	3200
3400	1060	1160	1275	1405	1550		2740	3000		2520	2700	3400
3600	1120	1230	1355	1490	1640		2900	3180		2700	2880	3600
3800	1180	1300	1430	1580	1735					2890	3070	3800
4000	1250	1380	1510	1665	1830					3070	3265	4000
4200	1310	1455	1590	1750	1930					3265	3450	4200
4400	1370	1520	1665	1830	2020					3465	3640	4400
4600	1440	1590	1745	1920	2120					3660	3830	4600
4800	1500	1660	1820	2005	2215					3845	4025	4800
5000	1560	1730	1890	2090	2310					4050	4220	5000

RANGE DESIRED (NAUTICAL MILES)

NOTE:
1) Fuel quantities are in U.S. Gallons.
2) Ranges are in nautical miles.
3) Ranges are approximately 5% conservative.

30561
2999

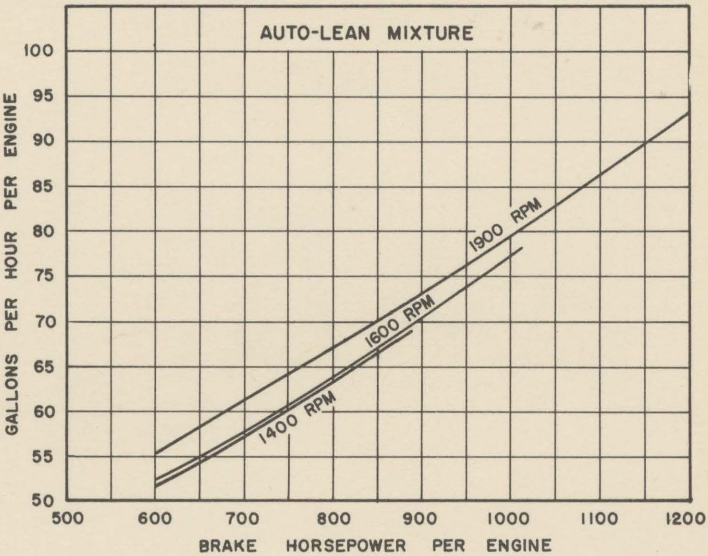
		Maximum Emergency Power	Maximum Continuous Power	Maximum Recommended Power	Long Range		
RPM		2600	2400	1900	As Required for Proper Airspeed		
Maximum Allowable Manifold Pressure		46" Hg.	42" Hg.	30" Hg.	30" (Except 2400 RPM)		
BMEP		200 or full throttle	197 or full throttle	140	As Required for Proper Airspeed		
Mixture		Auto-Rich	Auto-Rich	Auto-Lean	Auto-Lean (Except 2400 RPM)		
Maximum Cylinder Temperature °C.		248 (5 Min. Only)	218 (232 for 1 Hr. Only)	205	205		
Gallons Per Hour (Total 2 Eng.)		580	485	176	Refer to Fuel Cons. Chart Page		
		T.A.S. ↓	T.A.S. ↓	T.A.S. ↓	T.A.S. ↓	Pilot's I.A.S. ↓	RPM
Heavy Weight (65,000-75,000 Lbs.)	Sea Level	A-180	B-172	X	S-132	140	1900
	5,000 Feet	B-182	C-177	X	R-142	140	2400
	10,000 Feet	C-176	E-170	X	X	X	X
Average Weight (55,000-65,000 Lbs.)	Sea Level	A-182	B-176	K-137	L-122	130	1600
	5,000 Feet	B-187	C-181	K-142	L-132	130	1900
	10,000 Feet	C-181	E-176	K-146	L-143	130	1900
Light Weight (Below 55,000 Lbs.)	Sea Level	A-185	C-178	K-141	M-113	120	1400
	5,000 Feet	B-189	C-184	K-147	M-122	120	1400
	10,000 Feet	D-185	E-180	L-154	M-132	120	1600

RPM's between 1900 and 2400 cannot be used with #1014 propeller blades.

FIG. 32 OPERATION CHART

30562 . 3000

LEVEL FLIGHT CHART

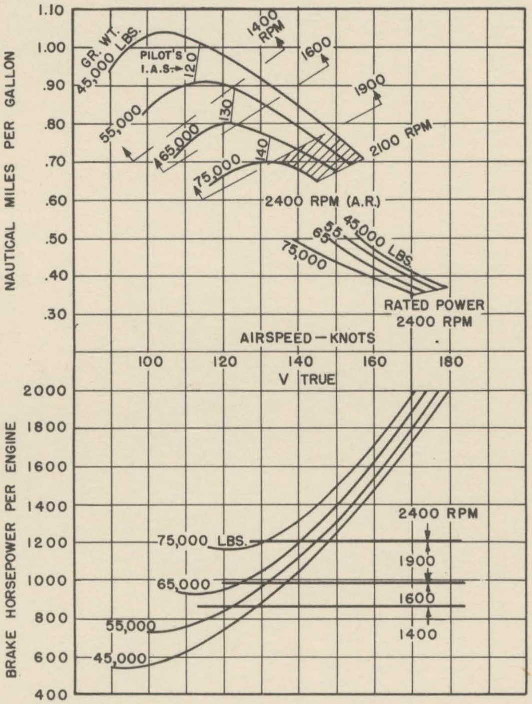


CLIMB CHART

WEIGHT CONDITION	I.A.S. KNOTS	5,000 FT. TIME FROM S.L. MINUTES	5,000 FT. FUEL FROM S.L. GALLONS	10,000 FT. TIME FROM S.L. MINUTES	10,000 FT. FUEL FROM S.L. GALLONS
HEAVY -75,000 #	130	11	84	31	228
AVERAGE - 65,000 #	130	7	56	18	130
LIGHT - 55,000 #	130	5	42	13	94
RATED POWER OR FULL THROTTLE — 2400 RPM					

FIG. 33 FUEL CONSUMPTION CHARTS

30559



SEA LEVEL

NOTE: CROSS-HATCHED AREA UNDER MILES / GALLON CANNOT BE USED WITH # 1014 PROPELLERS. GO TO 2400 RPM, AUTO-RICH, FOR HIGHER POWER.

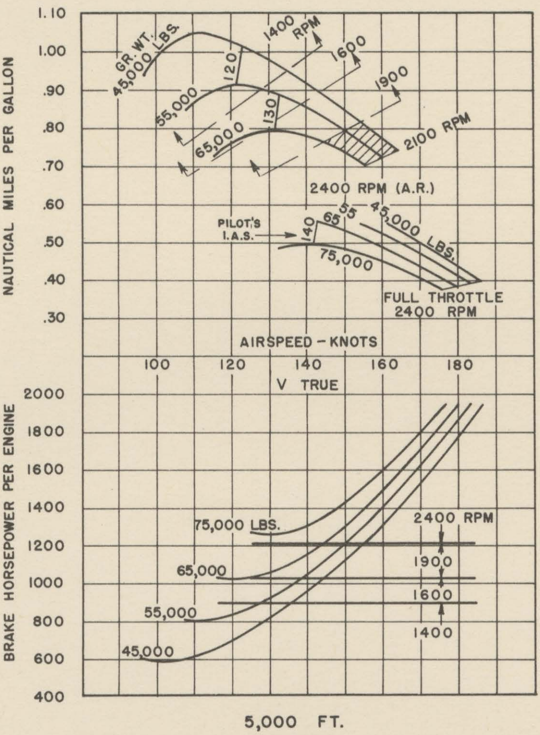
LONG RANGE CRUISE:

HEAVY WT. (75,000-65,000 LBS.)	1900 RPM, AUTO-LEAN,	140 KNOTS PILOT'S I.A.S.
AVER. WT. (65,000-55,000 LBS.)	1600 RPM, " " ,	130 KNOTS " "
LIGHT WT. (55,000-45,000 LBS.)	1400 RPM, " " ,	120 KNOTS " "

IF AIRSPEED CANNOT BE OBTAINED WITHOUT EXCEEDING 30" M.P. AT THIS RPM, USE NEXT HIGHER RPM AS SHOWN ON ABOVE CURVES.

30556

FIG. 34 CRUISING CONTROL CHART - SEA LEVEL



NOTE: CROSS-HATCHED AREA UNDER MILES/GALLON CANNOT BE USED WITH # 1014 PROPELLERS. GO TO 2400 RPM, AUTO-RICH, FOR HIGHER POWER.

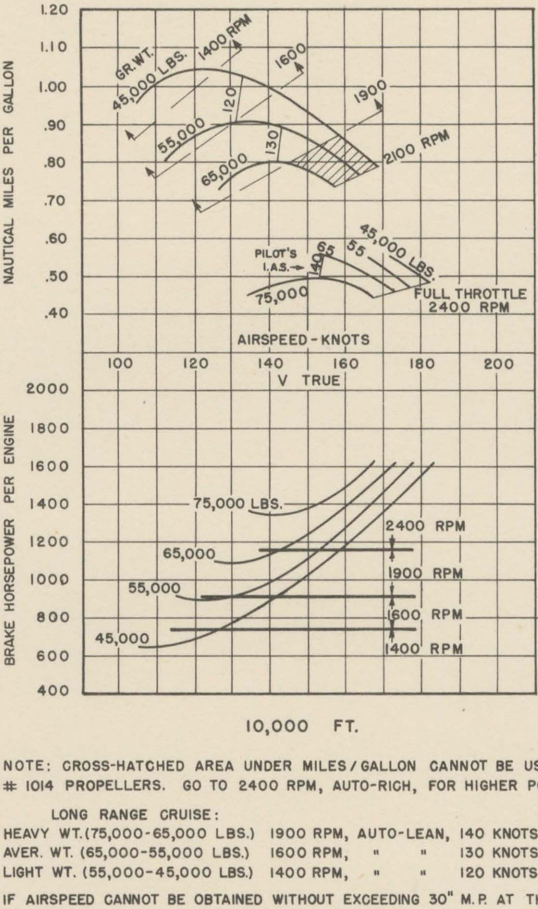
LONG RANGE CRUISE:

HEAVY WT. (75,000-65,000 LBS.) 1900 RPM, AUTO-LEAN, 140 KNOTS PILOT'S I.A.S.
AVER. WT. (65,000-55,000 LBS.) 1600 RPM, " " , 130 KNOTS " "
LIGHT WT. (55,000-45,000 LBS.) 1400 RPM, " " , 120 KNOTS " "

IF AIRSPEED CANNOT BE OBTAINED WITHOUT EXCEEDING 30" M.P. AT THIS RPM, USE NEXT HIGHER RPM AS SHOWN ON ABOVE CURVES.

FIG. 35 CRUISING CONTROL CHART - 5000 FT.

30557



10,000 FT.

NOTE: CROSS-HATCHED AREA UNDER MILES / GALLON CANNOT BE USED WITH # 1014 PROPELLERS. GO TO 2400 RPM, AUTO-RICH, FOR HIGHER POWER.

LONG RANGE CRUISE:

HEAVY WT. (75,000-65,000 LBS.)	1900 RPM, AUTO-LEAN,	140 KNOTS PILOT'S I.A.S.
AVER. WT. (65,000-55,000 LBS.)	1600 RPM, " "	130 KNOTS " "
LIGHT WT. (55,000-45,000 LBS.)	1400 RPM, " "	120 KNOTS " "

IF AIRSPEED CANNOT BE OBTAINED WITHOUT EXCEEDING 30" M.P. AT THIS RPM, USE NEXT HIGHER RPM AS SHOWN ON ABOVE CURVES.

30558

FIG. 36 CRUISING CONTROL CHART - 10,000 FT.

4. NORMAL INSTRUMENT READINGS

a. DESCRIPTION OF CONDITION

These instrument readings are for average weights and standard atmospheric conditions, and will change with variations from standard conditions. At higher or lower weights, the takeoff and cruising speeds will differ, while the cruising RPM will vary with both weight and altitude. See the Flight Instructions and the Flight Operations Charts for detailed information.

b. READINGS

Gross Weight—55,000 lbs. — 65,000 lbs. Up to Engine Critical Altitude				
	TAKEOFF	CLIMB	CRUISING	HIGH SPEED
Mixture Control	Auto Rich	Auto Rich	Auto Lean	Auto Rich
Tachometer (RPM)	2550	2400	1600	2400
Manifold Pressure (in. Hg.)	46	44 (S.L.) 42.5 (4000′)	30 max.	42.5
BMEP (psi)	200	197 or full throttle	150 max.	197
I.A.S. (knots)	75	130	130	205
Fuel Pressure (psi)	17	17	17	17
Oil Pressure (psi)	75	75	75	75
Oil Temperature (°C.)	70	70	70	70
Cyl. Head Temp. (°C.)	248 max.	232 max.	205 max.	232 max.
Cowl Flaps	One-half	One-third	Adjust to maintain cylinder temp.	Closed

Section VII
FLYING CHARACTERISTICS

1. WEIGHT DISTRIBUTION TABULATION

a. CREW

		Weight	*Arm*	*Index Units*
(1)	NORMAL FLIGHT POSITIONS	1800	272.1	—6.92
	Pilot	180	173.0	—1.05
	Copilot	180	173.0	—1.05
	Commander	180	232.0	— .84
	Navigator	180	316.0	— .53
	Engineer	180	330.0	— .48
	Radio Operator	180	238.0	— .82
	Gunner—Bow	180	39.0	—1.53
	Gunner—Upper Waist	180	594.0	.47
	Man in Officers' Quarters	180	213.0	— .90
	Man in Crews' Quarters	180	413.0	— .19
(2)	BATTLE POSITIONS	1800	408.3	—2.00
	Pilot	180	173.0	—1.05
	Commander	180	232.0	— .84
	Bomber	180	40.0	—1.53
	Engineer	180	330.0	— .48
	Radio Operator	180	238.0	— .82
	Gunner—Bow	180	39.0	—1.53
	Gunner—Upper Waist	180	594.0	.47
	Gunners—Side Waist (2)	360	670.0	1.48
	Gunner—Tail	180	1099.0	2.28

b. PARACHUTES AND LIFE JACKETS

		Weight	*Arm*	*Index Units*
(1)	NORMAL FLIGHT POSITIONS	200.0	264.0	— .80
	Pilot	20	180.0	— .11
	Copilot	20	180	— .11
	Commander	20	223	— .10
	Navigator	20	255	— .08
	Engineer	20	276	— .08
	Radio Operator	20	223	— .10
	Gunner—Bow	20	65	— .16
	Gunner—Upper Waist	20	594	.05
	Man in Officers' Quarters	20	181	— .11
	Man in Crews' Quarters	20	460	.00
(2)	BATTLE POSITIONS	200.0	389.4	— .30
	Pilot	20	180.0	— .11
	Commander	20	223.0	— .10
	Bomber	20	91.0	— .15
	Engineer	20	276.0	— .08
	Radio Operator	20	223.0	— .10
	Gunner—Bow	20	65.0	— .16
	Gunner—Upper Waist	20	594.0	.05
	Gunners—Side Waist (2)	40	610.0	.11

	Weight	Arm	Index Units
Gunner—Tail	20	1059.0	.24
GUNS	1626.4	597.8	4.34
Bow Gun Installation (Incl. Ammunition)	405.6	27.8	—3.54
Upper Waist Gun Installation (Incl. Ammunition)	405.6	592.5	1.04
Side Waist Guns Installations (Incl. Ammunition)	409.6	660.0	1.60
Tail Gun Installation (Incl. Ammunition)	405.6	1110.0	5.24
d. BOMBING EQUIPMENT	51.2	122.6	— .00
One Mark XV-4 Bombsight	34.8	24.8	— .31
Two Firing Keys NA-41A (NAF STD. 1080)	1.5	92.8	— .01
Pilot Director Indicators	2.2	139.3	— .01
Bomb Shackles	5.9	404.5	— .01
Bomb Release Units	6.8	404.5	— .01
e. PYROTECHNIC INSTALLATION	269.7	442.2	— .12
Smoke Grenades (4 H.C., M-8)	7.2	259.0	— .03
Float Lights (40 Lights, MK IV)	88.0	465.8	.00
Flares (8 Flares MK IV-1 B.O. 115019)	156.0	465.8	.00
Very's Pistol (B.O. 11254-C)	2.4	145.0	— .02
Very's Pistol Ammunition—24 Rds.	1.7	145.0	— .01
Pyrotechnic Pistol (M-2)	3.2	242.0	— .01
Pyrotechnic Pistol Ammunition—20 Rds.	11.2	242.0	— .05
**f.* COMMUNICATION EQUIPMENT	471.6	247.1	—2.05
Main Radio	308.6	240.8	—1.38
Intrasquadron Maneuvering	58.7	243.0	— .26
Direction Finder	66.0	267.5	— .00
Interphone Unit	38.3	268.6	— .15

* Government Furnished

	Weight	Arm	Index Units
g. NAVIGATING EQUIPMENT	47.0	304.8	— .15
h. MISCELLANEOUS EQUIPMENT	948.0	314.1	—2.85
Emergency Water and Containers	127.0	341.8	— .31
Emergency Food	100.0	308.5	— .31
Life Rafts (2)	116.2	303.8	— .37
Water	136.0	285.0	— .49
Food	100.0	320.0	— .29
Bedding and Blankets	100.0	331.3	— .27
Personal Effects (10 men)	190.0	336.5	— .47
Spotlight	5.8	253.5	— .02
Sea Anchor	11.0	594.0	.03
Flashlights (7)			
First Aid Kit	3.0	363.4	— .01
Canvas Bucket	2.0	564.8	.00
Boat Hook	3.5	113.0	— .02
Buoy Hook (with 100′ Manila Rope)	6.8	113.0	— .05

	Weight	Arm	Index Units
Handling Ropes (2-150 Ft. Each)	21.5	65.0	— .17
Airplane Tool Kit	10.0	266.2	— .04
Engine Tool Kit	12.0	266.2	— .04
Signal Flags	1.0	290.2	.00
i. OXYGEN EQUIPMENT	415.2	306.6	—1.00
(1) Rebreathers and Canisters	271.0	392.4	— .39
Bomber	14.0	40.0	— .12
Pilot	20.0	173.0	— .12
Copilot	15.0	173.0	— .09
Commander	15.0	232.0	— .07
Radio Operator	20.0	238.0	— .09
Navigator	15.0	316.0	— .04
Engineer	20.0	330.0	— .05
Gunner—Side Waist (2)	44.0	670.0	.18
Gunner—Tail	22.0	1099.0	.28
Gunner—Upper Waist	27.0	594.0	.07
Gunner—Bow	27.0	39.0	— .23
Crews' Quarters	12.0	413.0	.01
Officers' Quarters	20.0	213.0	— .10
(2) Oxygen Cylinders	144.0	145.0	— .92
j. FUEL AND OIL FOR AUXILIARY POWER PLANT	180.0	383.8	— .29
(1) Fuel (25 Gallons)	150.	438.9	— .08
(2) Oil (4 Gallons)	30.	121.8	— .00
k. ITEMS NOT INCLUDED IN COMBAT BASIC WEIGHT			
(1) Torpedo (Mark XV)	3430.0	398.2	—4.54
(2) Torpedo (Mark XIII)	1932.0	405.7	—2.28
(3) Torpedo Installation (Mark XIII or XV)	239.2	408.0	— .27
(4) Torpedo Installation (Mark XIII only)	58.6	417.1	— .06
(5) 500 Lb. Bomb (Incl. Release Unit & Shackle)	507.0	405.0	— .60
(6) 1000 Lb. Bomb (Incl. Release Unit & Shackle)	1007.0	405.0	—1.20
(7) Torpedo Director	3.5	157.0	— .02
l. ADDITIONAL EQUIPMENT CARRIED FOR ASSISTED TAKE-OFF	181.5	409.3	— .20
CO_2 Bottles (Vapor Dilution)	96.8	360.0	— .21
Headrests	4.2	268.7	— .02
Disconnect Plug—Catapult Phone	.5	618.0	.00
Catapult Fittings	75.3	480.8	.02
Oxygen Supports	4.7	604.0	.01

m. SPECIAL LOAD ITEMS

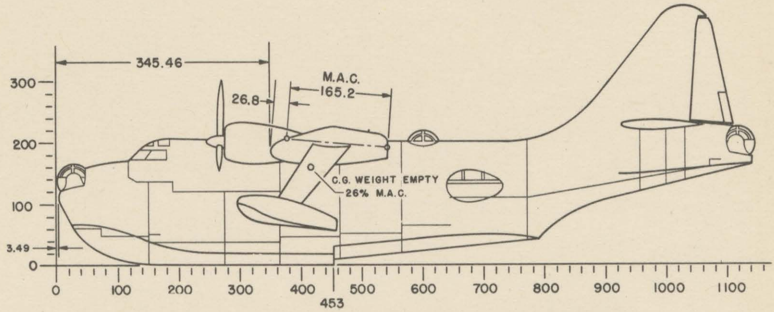
The following special load items are not included in the normal weight empty condition of the airplane and are classed as overload when carried:

	Weight	*Arm*	*Index Units*
Beaching Gear (Stowed)	7175.9	411.6	—7.58
Hoisting Sling—Airplane	223.6	618.0	.69
Wing Hoist Fittings (No Stowage Provided)	2.2		
Engine Covers (No Stowage Provided)	39.7		
Deicing Boots	246.7	519.4	.27
Propeller Anti-Icing Fluid	117.6	356.6	— .25
*CO_2 Bottles (Vapor Dilution)	96.9	360.0	.20
Auxiliary Bomb Racks—100 Lb. Bombs	116.6	404.6	— .14
Bombsight Supports	13.9	29.0	— .12
Engine Heating Ducts (No Stowage Provided)	13.9		
Thermocouple—Multiplace	64.4	350.1	— .15
Auxiliary Power Plant Hoist	61.4	616.5	.19
Solid Fuel—Water Distiller	17.7	290.4	— .06
*Catapult Accessory Equip. (Trunnions, etc.)	84.6	478.1	.02
Gun Cameras	13.8	610.0	.04
Ice Abrasion Plates	24.6	259.9	— .10
Ladder—Main Entry (No Stowage Provided)	10.7		
Engine Hoist and Sling	205.0	414.2	— .21
Special Bomb Hoist (No Stowage Provided)	132.9		
Bomb Hoist	399.0	419.0	— .36
Test Record Set & Equipment	339.3	378.9	— .58
100 Lb. Practice Bombs	114.0	406.8	— .13
Bomb and Torpedo Hoist Stowage	11.8	419.0	— .01
Service Platform Truss (Torpedo Supt.—No Stowage Provided)	2.5		
Oil—Out Thermometer	1.7	340.0	.00
Water—Built In System	166.6	392.3	— .24
Target Reel Inst. (Condition 1)	112.7	775.0	.70
Target Reel Inst. (Condition 2)	130.2	775.0	.81
Starter Crank	12.8	350.0	— .03
Hoisting Slings—Turrets (No Stowage Provided)	3.0		
**Armor Plate			
Side Turret (2)	226.2	660.0	.88
Bow Turret	129.0	27.8	—1.13

	Weight	*Arm*	*Index Units*
Upper Turret	129.0	592.5	.33
Tail Turret	129.0	1110.0	1.67
Engineer	191.3	362.5	.39
Pilot and Copilot	180.7	198.5	— .96
Catapult Handling	17.3	276.0	— .07

* Included in catapult weight empty.

** For detail weights on armor plating see Erection and Maintenance Instructions, Armament Supplement.



NO.	ITEM	WEIGHT	HORIZONTAL		VERTICAL	
			ARM	MOMENT	ARM	MOMENT
1	WING GROUP	11216.2	432.0	4845722	188.4	2113687
2	HORIZONTAL TAIL GROUP	683.0	989.4	675751	227.9	155654
3	VERTICAL TAIL GROUP	391.3	995.4	389491	290.4	113616
4	HULL	8836.0	449.2	3969389	101.2	894573
5	NACELLE AND COWLING	1163.3	324.5	377520	193.9	225590
6	WING TIP FLOATS	698.6	389.6	272160	109.9	76790
	TOTAL STRUCTURE	22988.4	458.1	10530033	155.7	3579910
7	ENGINES	5205.0	299.5	1558898	196.7	1023824
8	ENGINE ACCESSORIES	229.4	313.4	71890	199.0	45660
9	ENGINE CONTROL	134.1	332.2	44548	188.2	25241
10	PROPELLERS	1330.9	266.8	355098	194.6	259001
11	STARTING SYSTEM	110.4	335.4	37024	197.6	21817
12	LUBRICATION SYSTEM	390.8	352.1	137588	172.6	67448
13	FUEL SYSTEM	353.5	394.7	139509	175.6	62058
	TOTAL POWER PLANT	7754.1	302.4	2344555	194.1	1505049
14	INSTRUMENTS	198.1	281.0	55661	175.4	34752
15	SURFACE CONTROL	632.2	361.1	228262	153.8	97261
16	ELECTRICAL	852.8	319.0	272049	149.7	127647
17	ARMAMENT PROVISION	2202.2	585.4	1289125	162.3	357382
18	FURNISHINGS	1855.9	313.2	581189	111.9	207618
19	ANTI-ICING EQUIPMENT	233.5	397.0	92706	179.3	41859
20	AUXILIARY POWER PLANT	384.1	150.1	57667	85.0	32636
21	AUXILIARY GEAR	154.3	87.9	13560	103.1	15912
	TOTAL FIXED EQUIPMENT	6513.1	397.7	2590219	140.5	915067
	UNACCOUNTED FOR	127.9		68037		14979
22	WEIGHT EMPTY	37383.5	415.5	15532844	160.9	6015005
	CATAPULT EQUIPMENT	181.4	414.9	75255	65.4	11862
23	CATAPULT WEIGHT EMPTY	37564.9	415.5	15608099	160.4	6026867

BASIC DATA

LENGTH OF M.A.C.	165.2"
MAXIMUM FORWARD C.G.	20% M.A.C.
MAXIMUM AFT. C.G.	32% M.A.C. (APPROX.)

$$\text{INDEX UNITS} = \frac{(\text{ARM OF ITEM} - 464.4)\ (\text{WEIGHT OF ITEM})}{50{,}000}$$

WEIGHT EMPTY	INDEX UNITS	C.G. IN % OF M.A.C.
37383.5	35.6	26%

NOTE: ACTUAL DETAIL WEIGHTS AS OF 12-9-42

FIG. 37 BALANCE DIAGRAM

2. AIRPLANE BALANCE

a. CENTER OF GRAVITY CALCULATION

The airplane weight empty is the basis of all computation of airplane balance. All items listed under weight empty in the balance diagram Figure 44, must be in the airplane at all times or accounted for by ballasting or by calculating the change in C.G. position due to their removal. All other items are listed under weight distribution tabulations with the weight of each and the arm or distance in inches horizontally from the reference line. All items of the useful load or special load must be individually accounted for in loading the airplane by adding the weight of each to the airplane weight empty and by adding (algebraically) the index units of each to the index units of the airplane weight empty. The balance condition is determined by the number of index units per gross weight of the airplane. Index units for fuel and oil may be taken from the charts Figures 45, 46, 47, and 48. Index units for bombs and other useful load may be found in the tabulations. Index units for any other items to be carried in the airplane must be calculated.

Index units are merely balance units calculated from the following formula:

$$\frac{(\text{Arm of Item}—464.4)\ (\text{Weight of Item})}{50000} = \text{Index Units}$$

The point 464.4 is the intersection of the rear spar and the wing chord plane at Station 0 of the wing and is the arbitrary point selected near the average center of gravity.

In finding index units for fuel and oil from the charts, care should be taken to find index units for the exact amount of fuel in each individual tank and add index units rather than adding the weight of fuel before attempting to find index units.

For computing weight the following unit weights are used:

Gasoline	6	pounds per gallon
Oil	7.5	pounds per gallon
Water	8.34	pounds per gallon

To find the center of gravity for a specific loading condition refer to the center of gravity grid, Figure 49. Locate the line representing the gross weight of the airplane and follow that line to the intersection of the line representing the index units for that load condition. This point represents the center of gravity in percent of the mean aerodynamic chord. The exact value may be obtained by interpolating between the percentage lines shown. If the C.G. position thus determined is found to be forward or aft of the desired or permissible C.G., a redistribution of weight may be necessary. It is also essential that the C.G. be calculated for the estimated landing condition or any condition that may occur during flight and disposal of bombs and fuel.

The most forward limit of the C.G. is 20% MAC and the most aft limit is approximately 32% MAC, depending on the gross weight and loading condition. See Figure 49. For safe takeoff, flight and landing, the C.G. should never exceed these limits.

From the tabulation of weights it is possible to calculate the center of gravity of the airplane for any condition of loading.

The maximum allowable gross weight for non-assisted takeoff is 64,034 pounds. For assisted takeoff the maximum gross weight is 101,129 pounds.

The following is an example for calculation of center of gravity for a given load condition:

Item	*Weight*	*Index Units*
Airplane, weight empty	37,383.5	—36.5
Crew	1,800.0	— 6.92
Parachutes	200.0	— .80
Fuel		
Main Tank R.H. 1372.5 gals.	8,235.0	— 7.08
Main Tank L.H. 1372.5 gals.	8,235.0	— 7.08
Outboard Tank—0 gals.		
Inboard Tank—0 gals.		
Oil		
Service Tank R.H. 76.5 gals.	571.8	— .90
Service Tank L.H. 76.5 gals.	571.8	— .90
Fuel, Auxiliary Power Plant 25 gals.	150.0	— .08
Oil, Auxiliary Power Plant 4 gals.	30.0	— .21
Gun Installation	1,626.4	4.34
2—500 Lb. Bombs & Shackles	1,005.9	— 1.19
Bombing Equipment	45.3	— .34
Communicating Equipment	471.6	— 2.05
Navigating Equipment	47.0	— .15
Pyrotechnic Installation	269.7	— .12
Miscellaneous Equipment	948.4	— 2.85
Oxygen Equipment	415.0	— 1.31
Total	62,006.4	—61.14

Refer to the center of gravity grid. The intersection of the line representing 62,006 lbs. gross weight and the line representing —61.14 index units falls between 24% and 26% MAC. By interpolation the correct center of gravity is found to be 24.4% of MAC.

b. SAMPLE LOADING CONDITIONS

(1) WEIGHT EMPTY

See balance diagram for list of items.

Weight	*Arm*	*Index Units*	*C.G. in % MAC*
37383.5	415.5	—35.75	25.7%

(2) WEIGHT EMPTY, CATAPULT CONDITION

Weight empty plus the following items from weight tabulations:

One—*l* (1)
One—*l* (2)

Weight	*Arm*	*Index Units*	*C.G. in % MAC*
37,564.9	415.5	—36.73	25.7%

(3) COMBAT BASIC WEIGHT

Weight empty plus the following items from weight tabulations:

One—*a* (1)
One—*b* (1)
One—*c*
One—*d*
One—*e*
One—*f*
One—*g*
One—*h*
One—*i*
One—*j* (1)
One—*j* (2)

Weight	*Arm*	*Index Units*	*C.G. in % MAC*
43392.6	410.3	—47.0	22.6%

(4) PATROL BOMBER, NORMAL (Unassisted)

Combat basic weight plus:

Two—*k* (5) Fuel—Main Tanks 2745 gals.
Oil— 153 gals

Weight	*Arm*	*Index Units*	*C.G. in % MAC*
62006.	412.8	—64.0	24.1%

(5) PATROL BOMBER, MAXIMUM (Unassisted)

Combat basic weight plus:

Six—*k* (5) Fuel—Main Tanks 2745 gals.
Oil— 153 gals

Weight	*Arm*	*Index Units*	*C.G. in % MAC*
64034.0	412.4	—66.63	24.0%

(6) NORMAL PATROL TORPEDO (Unassisted)

Combat basic weight plus:

One—*j* (1)	Fuel—Main Tanks	1760 gals.
One—*j* (2)	Oil—	98 gals.
Two—*k* (1)		
Two—*k* (3)		
One—*k* (7)		

Weight	*Arm*	*Index Units*	*C.G. in % MAC*
62006.0	410.7	—66.59	22.8%

(7) PATROL BOMBER (Assisted)

Combat basic weight plus:

One—*j* (1)	Fuel—Main Tanks	3100 gals.
One—*j* (2)	Outbd. Tanks	3254 gals.
Two—*k* (5)	Inbd. Tanks	2419 gals.
One—*l* (1)	Oil—	487 gals.
One—*l* (2)		

Weight	*Arm*	*Index Units*	*C.G. in % MAC*
101129.0	417.8	—94.16	27.1%

(8) PATROL AIRPLANE (Assisted)

Combat basic weight plus:

One—*j* (1)	Fuel—Main Tank	3121 gals.
One—*j* (2)	Inbd. Tank	2410 gals.
One—*l* (1)	Outbd. Tank	3400 gals.
One—*l* (2)	Oil—	496 gals.

Weight	*Arm*	*Index Units*	*C.G. in % MAC*
101129.0	418.2	—93.56	27.3%

(9) PATROL BOMBER (Assisted)

Combat basic weight plus:

One—*j* (1)	Fuel—Main Tanks	3121 gals.
One—*j* (2)	Inbd. Tanks.	2500 gals.
20 —*k* (6)	Outbd. Tanks	195 gals.
One—*l* (1)	Oil—	322gals.
One—*l* (2)		

Weight	*Arm*	*Index Units*	*C.G. in % MAC*
101129.0	411.9	—106.03	23.5%

(10) PATROL TORPEDO BOMBER (Assisted)

Combat basic weight plus:

One—*j* (1)			
One—*j* (2)			
Two—*k* (1)	Fuel—Main Tanks	3100	gals.
Two—*k* (3)	Inbd. Tanks	2500	gals.
Ten—*k* (6)	Outbd. Tanks	620	gals.
One—*k* (7)	Oil	346	gals.
One—*l* (1)			
One—*l* (2)			

Weight	*Arm*	*Index Units*	*C.G. in % MAC*
101129.0	412.3	—105.32	23.8%

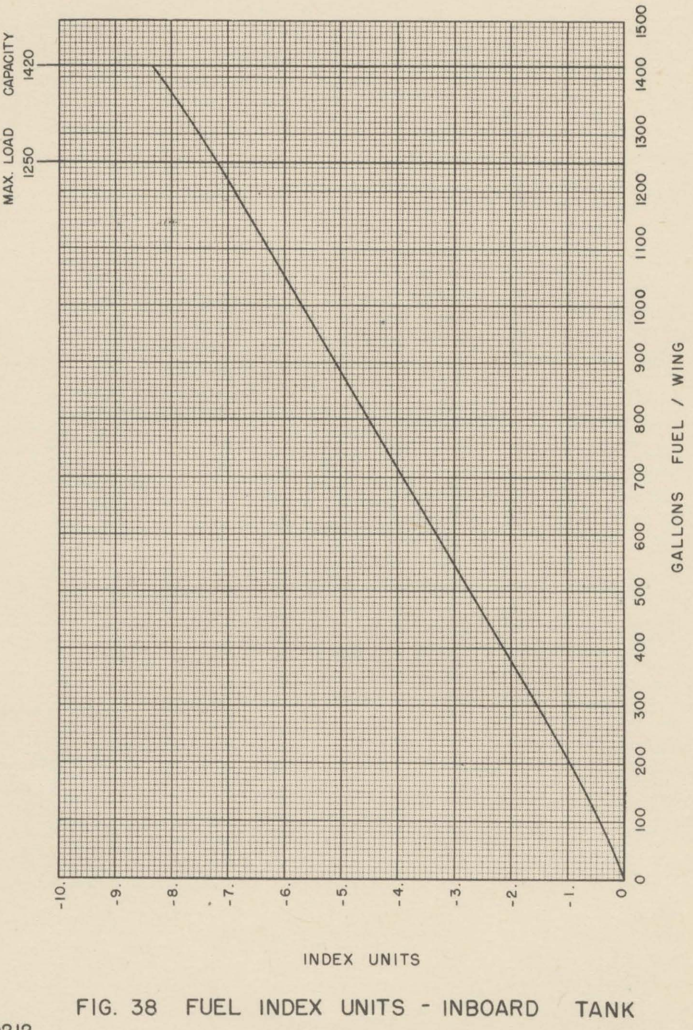


FIG. 38 FUEL INDEX UNITS - INBOARD TANK

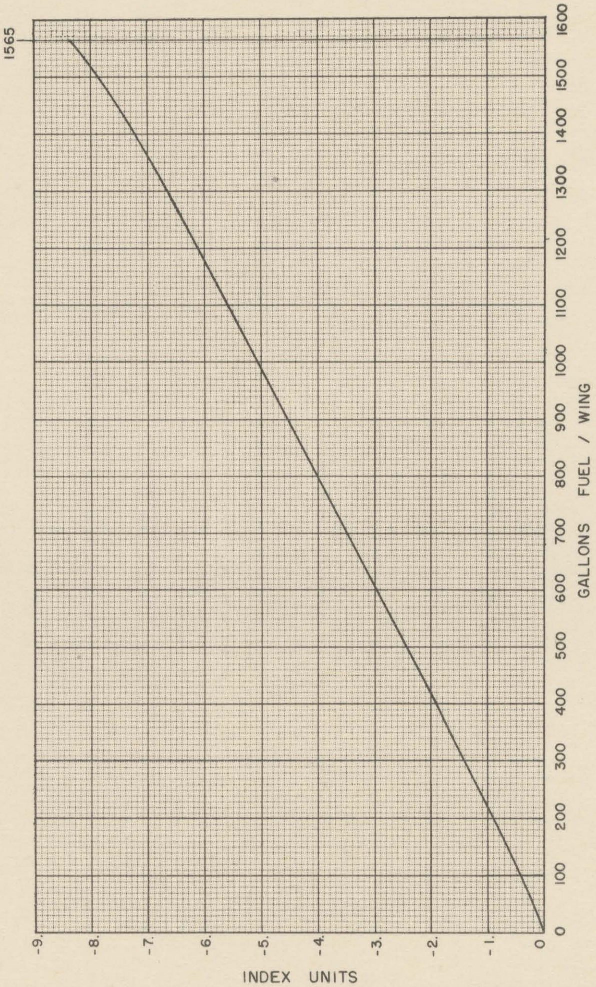


FIG. 39 FUEL INDEX UNITS MAIN TANKS

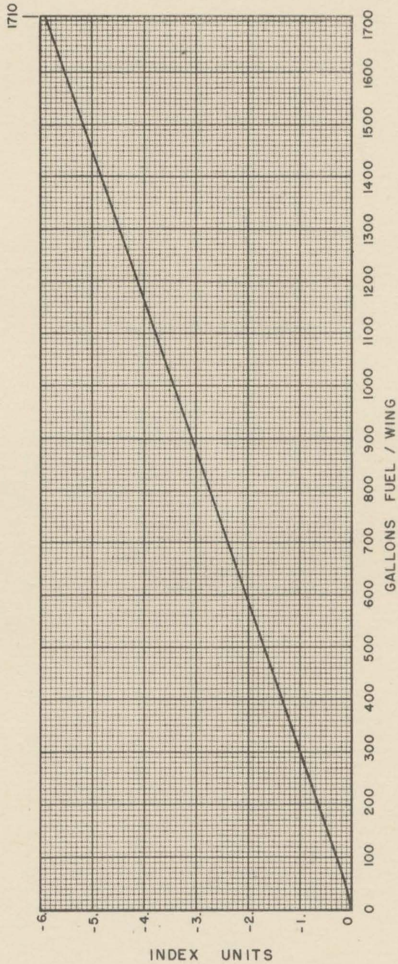


FIG. 40 FUEL INDEX UNITS - OUTBOARD TANKS

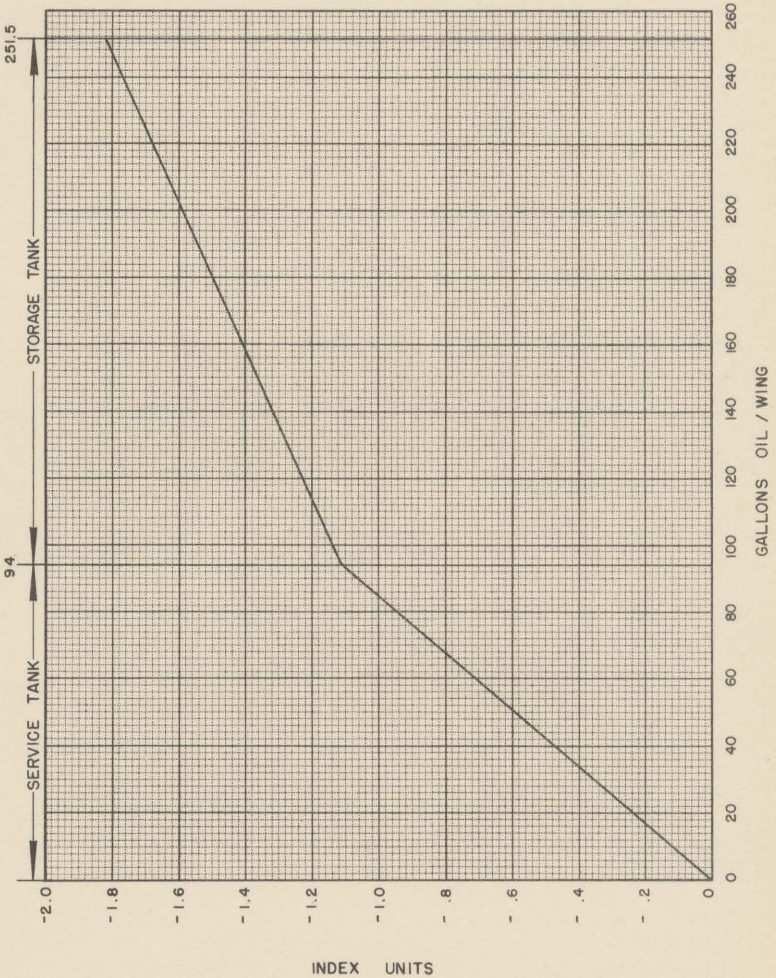


FIG. 41 OIL INDEX UNITS

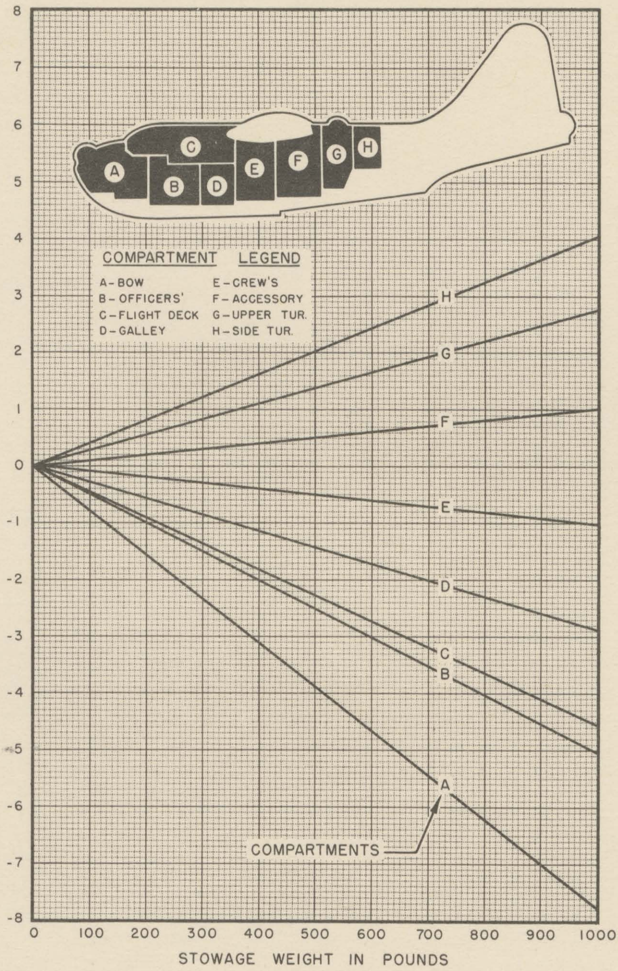


FIG. 42 INDEX UNITS — COMPARTMENT STOWAGE

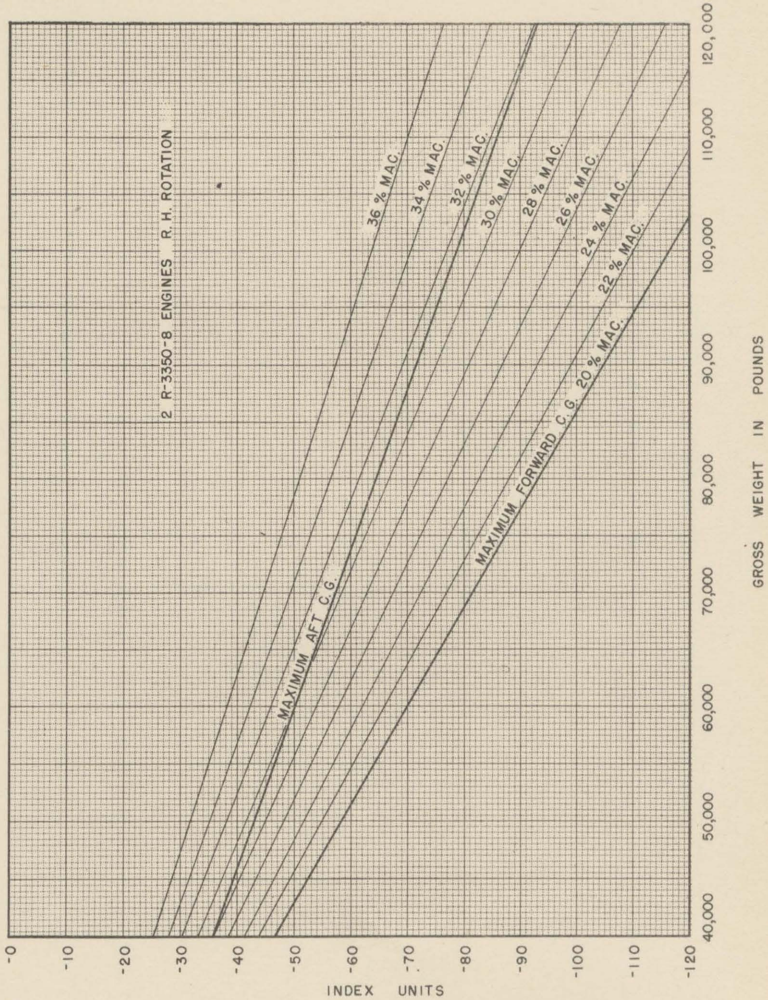


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FIG. 43 CENTER OF GRAVITY GRID

1544-A

REVISED 11-2-43

3. FLIGHT INSTRUCTIONS

a. TAKEOFF

Set flaps 30°, trim tabs zero, cowl flaps half open. Take off at 2550 RPM and 46 inches manifold pressure. Stick nearly full back up to hump speed and neutral from hump to takeoff speed. Pull airplane off at 85 knots IAS for heavy weights, 75 knots for average weights.

TAKEOFF

TAKEOFF TIME—SECONDS

Weight Condition	*No Wind*	*20 Knot Wind*
Heavy—75,000 Lbs.	98 sec.	55 sec.
Average—65,000 Lbs.	48 sec.	32 sec.
Light—55,000 Lbs.	39 sec.	25 sec.
Flaps 30°	2550 RPM	46″ Hg. M.P.

b. CLIMB

(1) Make all climbs up to 15,000 feet at 130 knots I.A.S., 2400 RPM with rated power to full throttle. Cowl flaps should be one-third open.

(2) Make all climbs above 15,000 feet at 115 knots I.A.S., 2400 RPM with rated power of full throttle. Cowl flaps should be adjusted to maintain allowable cylinder head temperatures of 232°C. Too much cowl flap will reduce climb and high speed and cause buffeting. (See also—Special Precautions, Par. 4 following.)

CLIMB

		5,000 Feet		10,000 Feet	
Weight Condition	*IAS*	*Time From SL*	*Fuel From SL*	*Time From SL*	*Fuel From SL*
	Knots	*Minutes*	*Gallons*	*Minutes*	*Gallons*
Heavy—75,000 lbs.	130	11	84	31	228
Average—65,000 lbs.	—	7	56	18	130
Light—55,000 lbs.	—	5	42	13	94

2400 RPM Rated Power or Full Throttle

c. LONG RANGE CRUISE

(1) HEAVY WEIGHT—75,000 lbs. to 65,000 lbs.

Fly at 1900 RPM. Adjust throttles to obtain 140 knots, pilot's I.A.S. Set cowl flaps 5° or to maintain 205°C. cylinder head temperature. Mixture—Auto Lean.

(2) AVERAGE WEIGHT—65,000 lbs. to 55,000 lbs.

Fly at 1600 RPM. Adjust throttles to obtain 130 knots, pilot's I.A.S. Set cowl flaps 5° or to maintain 205°C. cylinder head temperature. Mixture—Auto Lean.

(3) LIGHT WEIGHT—Below 55,000 lbs.

Fly at 1400 RPM. Adjust throttles to obtain 120 knots, pilot's I.A.S. Set cowl flaps 5° or to maintain 205°C. cylinder head temperature. Mixture—Auto Lean.

WARNING: Do not exceed 30″ Hg. manifold pressure. If the indicated air speed cannot be attained without exceeding 30″ Hg. at the above indicated RPM's, use the next higher allowable RPM. (Allowable RPM's: 1400, 1600, or 1900 with auto lean mixture, or 2400 RPM with auto rich mixture, and not over 42″ Hg. manifold pressure. Do not use 2400 RPM and auto rich for long range unless absolutely necessary.)

d. APPROACH

Approach with 30° flaps at 105 knots I.A.S.

e. LANDING

Land with full flaps. Raise flaps for taxi.

f. ONE ENGINE OUT

Fly at 115 knots, pilot's I.A.S., 2400 RPM, and rated power. If in the heavy weight condition, decrease altitude and dump bombs and/or fuel until level flight can be maintained.

4. SPECIAL PRECAUTIONS

a. EMERGENCY take-off RPM of 2600 is allowed.

When the No. 1018 propeller blades originally intended for this airplane are available, the above restrictions will be removed or modified.

b. TAXIING

The taxiing characteristics are normal for a large flying boat. Differential power is entirely adequate for control in any normal situation.

c. TAKE-OFF

There are no unusual take-off characteristics. With all trim tabs neutral and 30° flap the best technique seems to be to hold the wheel just forward of the full elevator up position until hump speed is reached. A slight forward pressure will be required to hold the wheel in this position. After planing speed is reached the elevator should be moved to a neutral position and the airplane allowed to assume a normal planing attitude. At 70 knots with normal gross weight the airplane can be pulled off if it is so desired. The porpoising characteristics are extremely good and no trouble should be encountered with them unless the airplane is deliberately forced into either the high or low porpoising angle range. The oscillations in both high and low angle porpoising are mild and can be immediately stopped by changing trim angle in the proper direction. During takeoff, attempt to keep the tip floats clear of the water (keep wings level) and do *not* use differential throttling.

d. STABILITY

The airplane is stable for all normal flight and loading conditions. A slight tail heaviness will be noticed in lowering the flaps or increasing power. The change in trim is not enough to require readjustment of the elevator tab.

e. MANEUVERS PROHIBITED

As with all large aircraft, acrobatics are prohibited.

f. SINGLE ENGINE OPERATION

The minimum airspeed at which single engine control can be maintained has not at the present time been accurately determined. However, single engine operation in flight indicates that control is adequate at reasonable low airspeeds. At 113 knots, I.A.S., with one propeller feathered, the airplane may be maneuvered very nicely.

g. STALLING

The stalling characteristics are unusually good. Ample warning is given in the stall by first moderate and then more severe buffeting of the tail surfaces as the stalling speed is reached. Both aileron and rudder control remain very good well into the stalling range. There is no tendency to fall off on either wing or to dive.

h. DIVING

The maximum diving speed at normal gross weight is 228 knots I.A.S.

i. LANDING

A normal landing approach speed of about 10 5knots is recommended for all normal conditions.

j. COWL FLAPS

Large cowl flap opening results in buffeting. Adequate cooling in climb can be obtained with one-third cowl flaps. On level flights, adequate cooling can be obtained with a cowl flap opening of 5° or less. No buffeting will occur if one-third cowl flap or less is used.

k. BOMB DOORS

In the event of the failure of either or both sets of the spoiler flaps, the bomb doors will have to be opened without the protection of the spoiler flaps.

When opening the bomb doors separately, buffeting will be noticed when the doors are between one-third and two-thirds open. There is no buffeting when the doors are full open. For this reason, the bomb doors should be kept in either the full open or full closed position and should not be left in the mid-travel position.

Section VIII
RECOMMENDED OPERATING SEQUENCES

BEFORE BOARDING AIRPLANE

Pilot	*Copilot*	*Engineer*
1. Weight Sheet—Check loading carefully. C.G. must be between 20% and 32% of MAC.	No action.	No action.
2. Make visual inspection of airplane and note: *a.* Inspection panels, doors and cowling secured. *b.* Mooring lines secure. *c.* External control surface locks removed. *d.* Fuel and oil filler well covers in place.	No action.	No action.

BEFORE STARTING ENGINES

	Pilot	*Copilot*	*Engineer*
1.	Unlock and operate flight controls through full range. Check visually. Push lock lever all the way forward.	Observe control surfaces on R.H. side for proper operation.	Set voltmeter selector switch to "BATT." and check battery voltage. (24 volts)
2.	Check interphone system to all stations.	No action.	Turn battery ON. Turn inverter and D.C. instruments ON.
3.	No action.	No action.	Check fuel and oil quantities.
4.	No action.	No action.	Turn both fuel tank selector valves to MAIN TANK.
5.	Direct engineer to start Auxiliary Power Plant.	No action.	Start Auxiliary Power Plant as follows: *a.* Set auxiliary power plant fuel selector valve to CROSS SUPPLY ON. *b.* Turn auxiliary power plant ignition switch ON. START until engine begins to fire. *c.* Hold auxiliary engine starting switch to START until engine begins to fire, then release. *d.* When engine starts, turn on engine oil heat until oil-in temperature reaches approximately 60°C. DO NOT USE OIL HEATER BEFORE STARTING ENGINE.

	Pilot	*Copilot*	*Engineer*
			e. When engine is warm and has attained proper speed (4100 RPM) turn auxiliary generator switch ON.
			f. Set voltmeter selector switch to AUX. GEN. and check generator voltage (should be 28.5 volts).
			g. When oil heat reaches 60°C. turn oil heat OFF.
6.	Order combustion chambers cleared on both engines.	No action.	No action.
7.	Ignition switches must be OFF.	Ignition switches must be OFF.	Ignition switches must be OFF.
8.	No action.	No action.	Move the left-hand starter switch to START.
9.	No action.	No action.	Hold booster cutoff switch in the OFF position. After 3 or 4 complete revolutions turn starter switch OFF.
10.	Make final check of mooring lines.	No action.	No action.

STARTING ENGINES

NOTE: The following procedure is intended to give only the sequence of starting and therefore no consideration has been given to mooring of the airplane while starting.

Pilot

1. Visually inspect the left-hand nacelle and direct engineer to prepare to start the left-hand engine.

Copilot

No action.

Engineer

Prepare to start left-hand engine as follows:

a. Open cowl flaps.

b. Close oil cooler exit door. Adjust switch to AUTO.

c. Set carburetor air control to DIRECT.

d. Set supercharger control to LOW ratio. Lock lever in position.

e. Turn the propeller master unit ON. (Indicator light will be energized when the unit has attained the selected speed.)

f. Adjust "PROPELLER PITCH" control until synchronizer tachometer indicates 2600 RPM.

g. Adjust mixture to IDLE CUTOFF.

h. Set throttle to obtain 1000 to 1200 RPM on starting.

Pilot	*Copilot*	*Engineer*
		i. Set propeller to low pitch (high RPM) as follows: Check propeller circuit breaker. (Button should be in.) Feathering switch must be in NORMAL. Hold left-hand propeller selector switch at INCR. RPM until low pitch is reached. Move the left-hand propeller selector switch to AUTO.
		j. Set fire extinguisher selector valve to L.H. engine. (Emergency external extinguishers should be available nearby.)
		k. Turn left-hand auxiliary fuel pump ON.
		l. Notify pilot—ready to start left-hand engine.
2. Acknowledge—Ready to start left-hand engine.	No action.	No action.
3. Visually inspect left-hand nacelle, turn left-hand ignition switch ON and direct engineer to start left-hand engine.	No action.	At command from pilot, start left-hand engine as follows:

Pilot	*Copilot*	*Engineer*
		a. Turn left-hand ignition switch to BOTH. Push master switch IN.
		b. Move left-hand starter switch to START and prime with primer switch approximately five seconds.
Watch for fire in nacelle.	No action.	*c.* If engine does not start at once, prime by moving mixture control to AUTO. RICH for one-half turn of the propeller, then back to IDLE CUTOFF. When engine starts, move mixture control immediately to AUTO. RICH. Open starter switch.
		CAUTION: Do not open throttle as lean mixture and backfire hazard will result. Do not overprime. See Sec. V.
		d. If necessary, keep engine firing by intermittent use of the primer.
		e. If engine stops, move mixture control immediately to IDLE CUTOFF and repeat procedure as necessary.
		f. When engine starts, observe oil

	Pilot	*Copilot*	*Engineer*
			pressure carefully. Pressure should rise to 40 PSI in a few seconds. If no oil pressure after ½ minute, stop engine and investigate.
4.	No action.	No action.	Notify pilot—Left-hand engine operating properly—Oil pressure up.
5.	No action.	No action.	Turn L.H. auxiliary fuel pump—OFF.
6.	Acknowledge left-hand engine started and order engineer to prepare to start right-hand engine.	Visually inspect right-hand nacelle and notify pilot—O.K. to start right-hand engine.	Prepare to start right-hand engine in same manner as left-hand engine.
7.	No action.	No action.	Notify pilot—Ready to start right-hand engine.
8.	Acknowledge—Ready to start right-hand engine. Turn right-hand ignition switch ON and order engineer to start right-hand engine.	Watch for fire in nacelle.	Start right-hand engine in same manner as left-hand engine except master propeller controls.

FIRE IN NACELLE AT ENGINE START

	Pilot	*Copilot*	*Engineer*
1.	Watch for fire in left-hand engine.	Watch for fire in right-hand engine.	Stand by to pull fire extinguisher when directed by pilot.
2.	No action.	Notify pilot if fire occurs in right-hand nacelle.	No action.
3.	Direct engineer—Fire in nacelle, set fire extinguisher and stop engines.	No action.	At command from pilot set fire extinguisher and stop engines with mixture control. Open throttles. Cut magneto switch when engine stops.
4.	No action.	No action.	Close cowl flaps and stand by for command to pull fire extinguisher charge.
5.	If fire persists, order engineer to pull fire extinguisher charge.	No action.	Pull fire extinguisher charge at command from pilot. WARNING: CO_2 supply is sufficient for only one nacelle.

NOTE: If engine accessory cowling is not installed, it is unlikely that the fire can be extinguished by the CO_2 system. External fire extinguishers therefore must be used.

6.	Before resuming operations after fire, be sure that CO_2 cylinder is replaced.	No action.	No action.

WARM-UP

	Pilot	*Copilot*	*Engineer*
1.	Operate wing flaps to all positions and check operation.	Check A.F.C.E.—should be OFF.	Carburetor air DIRECT. Cowl flaps open. Mixture AUTO. RICH. Oil cooler door on AUTO. Run engines at 1000 RPM until oil-in temperature reaches at least 30°C. (See BuAero. Tech. Order No. 24-41.)
2.	No action.	No action.	Turn generator ON.
3.	No action.	No action.	Notify pilot when oil and engine temperatures are normal.
4.	When notified by engineer "Engine temperatures normal," open throttles to 30″ Hg. MP long enough to check instruments.	Check moorings for slippage.	Check magnetos and fuel and oil pressure. Propeller in low pitch—Propeller selector switch—OFF. Check each magneto for RPM drop and smooth running. Fuel 15 to 19 PSI. Oil 70 to 80 PSI. Check each generator voltage 28.5 volts. Do not exceed 248°C. cylinder head temperature.
5.	No action.	No action.	Notify pilot—Ready for taxi.

TAXIING

	Pilot	*Copilot*	*Engineer*
1.	Order mooring lines disengaged.	Turn lights on or off as necessary.	Set cowl flaps full OPEN. Mixture—AUTO. RICH. Carburetor air—DIRECT. Watch engine temperature carefully during taxi. Do not exceed 248°C. cylinder head temperature.
2.	Perform taxi when waterway is clear. Engine RPM during taxi is governed by the nature and length of taxi required. Avoid low RPM or idling speed which may foul the spark plugs and avoid continued high RPM which may overheat the engines.	Watch for floating obstructions.	Notify pilot if cylinder head temperatures approach 248°C.

TAKEOFF, UNASSISTED

Pilot	*Copilot*	*Engineer*
1. Make engine run-up tests.	Check trim tabs—Neutral. A. F. C. E.—OFF.	Check propeller master unit 2550 RPM Oil Pressure 70-80 PSI Fuel Pressure 15-19 PSI Mixture AUTO RICH Cowl Flaps ½ OPEN Carburetor Air DIRECT Supercharger LOW speed and locked Maximum cylinder head temperature before start of takeoff—approximately 205°C. To be determined by experience. Since auxiliary fuel pumps were turned OFF when engines were started and observed to be operating properly—it may be advisable to preclude engine failure due to failure of main fuel pumps by starting auxiliary fuel pumps and keeping them ON until after takeoff has been accomplished.
2. Give directions to copilot for operation of flaps to 30°.	Operate flaps as directed.	No action.
3. Signal—"Ready for takeoff."	Acknowledge—"Ready."	Acknowledge—"Ready for takeoff," or if a delay is necessary, give cause.
4. Open throttles to 46.0″ MP.	Apply throttle brake at takeoff power.	Engine cylinder head temperature not to exceed 248°C.

Pilot	*Copilot*	*Engineer*
		(5 min. only.) Make constant check of instruments.
5. No action.	No action.	After takeoff drain fuel strainers by holding switch to L.H. and R.H. positions (approximately 10 seconds each). If auxiliary fuel pumps have been turned ON as a precautionary measure during takeoff, they should be turned OFF.

TAKEOFF, ASSISTED

Pilot

1. Make engine run-up tests.

Copilot

Check trim tabs—Neutral. A. F. C. E.—OFF. Adjust flaps to TAKEOFF.

Engineer

Check propeller master unit—2500 RPM.

Oil pressure	70-80 PSI
Fuel pressure	15-19 PSI
Mixture	AUTO RICH
Cowl Flaps	½ OPEN
Carburetor air	DIRECT
Supercharger	LOW speed and locked.

Maximum cylinder head temperatures before start of take-off approximately 205°C. Determine by experiment.

Since auxiliary fuel pumps were turned OFF when engines were started and observed to be operating properly—it may be advisable to preclude engine failure due to failure of main fuel pumps by starting auxiliary fuel pumps and keeping them ON until after the takeoff had been accomplished.

Pilot

2. Check aerial engineer's final report: Make sure that precautions have been taken for catapulting, all equipment securely stowed, doors and windows closed and locked and crew in positions at assigned stations.

Copilot

No action.

Engineer

No action.

	Pilot	*Copilot*	*Engineer*
3.	Signal each crew man—"Ready for takeoff."	Acknowledge—"Ready."	Acknowledge—"Ready for takeoff," or if delay is necessary, give cause.
4.	Open throttles to 46.0″ Hg. MP and when engines attain maximum RPM and HP, signal ground crew—"Ready for takeoff."	Apply throttle brake at takeoff power.	Engine cylinder head temperature not to exceed 248°C. (5 min only.) Make constant check of instruments.
5.	No action.	No action.	After takeoff drain fuel strainers by holding switch to L.H. and R.H. positions (approximately 10 seconds each). If auxiliary fuel pumps have been turned ON as a precautionary measure during takeoff, they should now be turned OFF.

CLIMB

Pilot	Copilot	Engineer
1. Immediately after takeoff, or not more than 5 minutes after beginning to takeoff, reduce MP to 42.5″ Hg.	Turn lights on or off as necessary.	Adjust cowl flaps as necessary for proper cooling. (232°C., one hour only, 218°C., continuous.) Oil cooler door on AUTO.
2. Reduce RPM to 2400 by adjusting master unit to 2400 RPM.	No action.	Check propeller synchronization.
3. Direct engineer to adjust engine controls to desired power.	Adjust trim tabs as necessary.	See Sec. V, for adjustment of engine controls.

FIRE IN NACELLE IN FLIGHT

	Pilot	*Copilot*	*Engineer*
1.	Warn engineer—Fire in L.H. nacelle.	Warn engineer and pilot—Fire in R.H. nacelle.	Locate fire and determine probable cause.
2.	No action.	No action.	Close cowl flaps.
3.	No action.	No action.	Close throttle.
4.	No action.	No action.	Close tank selector valve.
5.	No action.	No action.	If fire persists, set fire extinguisher valve and pull handle.
6.	No action.	No action.	If necessary to aid in extinguishing fire or to stop vibration, adjust mixture control to IDLE CUTOFF and feather propeller to stop engine.

FEATHERING LEFT-HAND PROPELLER

Equipment Affected:

1 Air Pressure Pump
1 Air Pressure and Vacuum Pump
1 Generator

	Pilot	*Copilot*	*Engineer*
1.	Close L.H. throttle and direct engineer to feather L.H. propeller.	Turn A.F.C.E. OFF.	Adjust mixture control on L.H. engine to IDLE CUTOFF.
2.	No action.	No action.	Check manifold pressure on L.H. engine to be sure power is OFF. Set L.H. propeller feathering switch to FEATHER until engine stops.
3.	No action.	No action.	Adjust instrument vacuum to R.H. engine.
4.	No action.	No action.	Turn L.H. propeller selector switch OFF.
5.	No action.	No action.	Close L.H. cowl flaps.
6.	No action.	No action.	Close L.H. oil cooler door then leave control switch OFF.
7.	No action.	No action.	Adjust L.H. carburetor air to ALTERNATE.
8.	Notify engineer when engine stops.	No action.	If turrets are to be operated, it will be necessary to start the auxiliary power plant while one engine is not running.

Pilot	*Copilot*	*Engineer*
9. Adjust trim tabs as required.	No action.	Turn ignition and auxiliary fuel pump OFF on L.H. engine.

NOTE: The above procedure is a method designed to protect the engine during a normal feathering operation. In emergency, operations 1 and 2 may be performed so quickly they would be almost simultaneous in order to stop the engine before serious damage resulted.

In single engine flight the available vacuum pump would be adjusted to instruments. Only two pressure pumps are available for deicer and no vacuum pump; therefore, the deicer system would operate inefficiently. No means is provided for turning off the anti-icer fluid to one engine while the anti-icer pump is running; therefore, unless actual icing conditions are being encountered it would be advisable to turn off the propeller anti-icer system.

FEATHERING RIGHT-HAND PROPELLER
EQUIPMENT AFFECTED:

2 Air Pressure and Vacuum Pumps
1 Generator

	Pilot	*Copilot*	*Engineer*
1.	Close R.H. throttle and direct engineer to feather R.H. propeller.	Turn A.F.C.E. OFF.	Adjust mixture control on R.H. engine to IDLE CUTOFF.
2.	No action.	No action.	Check manifold pressure on R.H. engine to be sure power is off. Set R.H. propeller feathering switch to FEATHER until engine stops.
3.	No action.	No action.	Set instrument vacuum to L.H. engine.
4.	No action.	No action.	Turn R.H. propeller selector switch OFF.
5.	No action.	No action.	Close cowl flaps.
6.	No action.	No action.	Close oil cooler door.
7.	No action.	No action.	Set carburetor air to ALTERNATE.
8.	No action.	Notify engineer and pilot when engine stops.	If turrets are to be operated, it will be necessary to start the auxiliary power plant.

	Pilot	*Copilot*	*Engineer*
9.	Adjust trim tabs as required.	No action.	Turn ignition and auxiliary fuel pump OFF on R.H. engine.

NOTE: The above procedure is a method designed to protect the engine during a normal feathering operation. In emergency, operations 1 and 2 may be performed so quickly they would be almost simultaneous in order to stop the engine before serious damage resulted.

In single engine flight the available vacuum pump would be adjusted to instruments. Only two pressure pumps are available for deicer and no vacuum pump; therefore, the deicer system would operate inefficiently. No means is provided for turning off the anti-icer fluid to one engine while the anti-icer pump is running; therefore, unless actual icing conditions are being encountered it would be advisable to turn off the propeller anti-icer system.

UNFEATHERING LEFT-HAND PROPELLER

	Pilot	*Copilot*	*Engineer*
1.	Notify engineer—Start L.H. engine. Pilot's ignition switch should be ON.	No action.	Set carburetor air to DIRECT. Tank selector valve to proper tank. Ignition on BOTH. Throttle to 500 RPM. Feather switch to NORMAL.
2.	No action.	No action.	Unfeather L.H. propeller by holding selector switch at INC. RPM until propeller reaches 500 RPM.
3.	No action.	No action.	Move mixture to AUTO RICH. Engine should start firing at once. Avoid overspeeding the engine while cold.
4.	No action.	No action.	Open the cowl flaps and as engine begins to warm up open the throttle to 1200 RPM and continue warm-up. Continue warm-up until oil-in reaches operating temperature (60°C.)
5.	No action.	No action.	Set propeller selector switch to AUTO. and open throttle.
6.	Acknowledge L.H. engine O.K. Adjust trim tabs as required.	No action.	When engines are synchronized, notify pilot—L.H. engine O.K.

UNFEATHER RIGHT-HAND PROPELLER SAME PROCEDURE AS LEFT-HAND PROPELLER

LANDING

Pilot	*Copilot*	*Engineer*
1. Notify crew — Prepare to land.	Turn off A.F.C.E.	Acknowledge—Prepare to land.
2. Direct copilot in operation of flaps. Check flares: To be removed before landing.	Operate landing lights or other lights as necessary.	Turn surface deicer and propeller anti-icer OFF.
3. Set propeller master unit to 2400 RPM:	No action.	Set mixture—AUTO, RICH. Carburetor air — DIRECT. Cowl flaps to maintain proper temperature. Avoid too rapid cooling.
4. Direct radio man to retract trailing antenna.	No action.	No action.
5. No action.	Operate flaps as directed. Do not begin to lower flaps above 140 MPH indicated. Retract as soon as airplane is on water. If second approach is made, retract as directed by pilot.	Open cowl flaps for taxi.

STOPPING ENGINES

Pilot	*Copilot*	*Engineer*
1. Direct engineer — "Stop engines."	Turn off navigation lights not needed.	Stop engines as follows: *a.* Cowl flaps full OPEN. *b.* With the controls set as in landing, idle the engine at 600-800 RPM until cylinder head temperatures drop to 149°C. *c.* Increase engine RPM to 1000-1200 RPM and hold for ½ minute, then move mixture control to IDLE CUTOFF. *d.* Turn ignition OFF after propeller stops turning. *e.* Turn tank selector valves OFF unless using auxiliary power plant or cabin heater.
2. Lock throttle and flight controls.	No action.	Close cowl flaps after engines are thoroughly cooled. Close oil cooler door. Turn auxiliary fuel pump OFF.
3. Turn pilot's ignition OFF. Direct mooring of airplane.	No action.	Turn instruments OFF (Inverter and D.C. Instruments). Turn generators OFF. Turn battery OFF before leaving airplane.