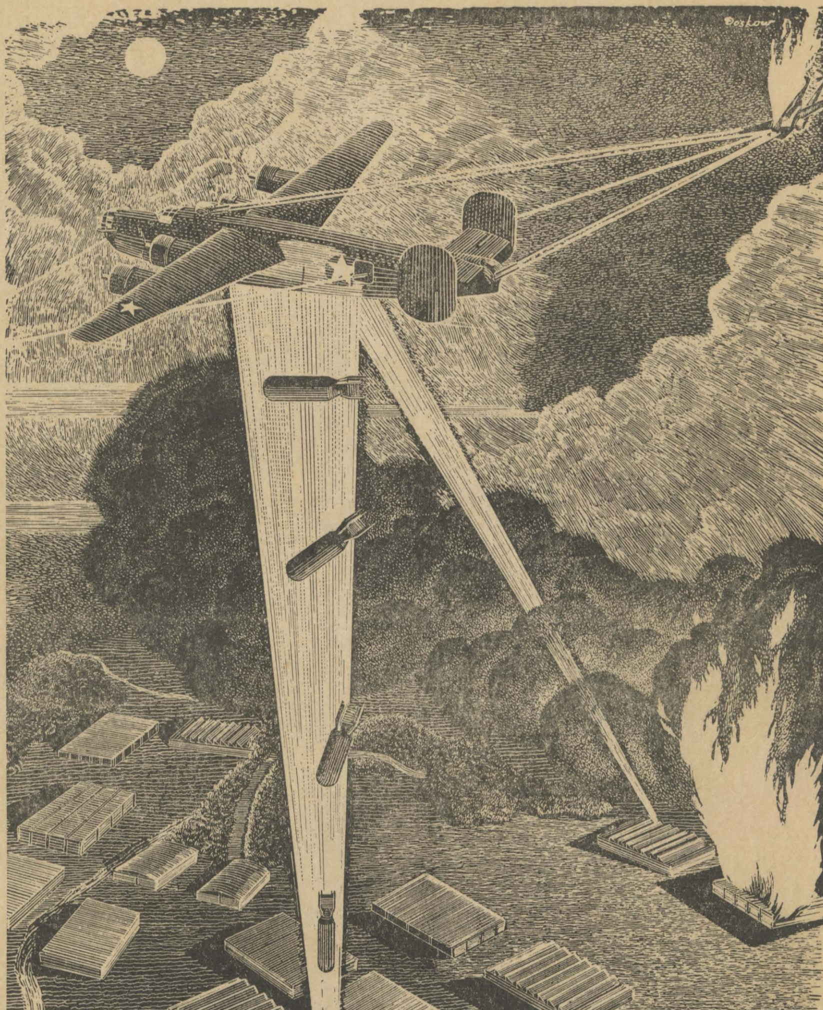
E H Hansen

PILOT'S GUIDE

CONSOLIDATED "LIBERATOR"
PB4Y-1 TYPE AIRCRAFT



TRANSITION LANDPLANE UNIT

HEADQUARTERS SQUADRON
FLEET AIR WING FOURTEEN

FOREWORD

This "Pilot's Guide" has been prepared by the Crew Flight Training Department of Transition Landplane Unit, Headquarters Squadron, Fleet Air Wing Fourteen primarily for the instruction and guidance of student pilots undergoing indoctrination in the "Liberator" (PB4Y-1) type aircraft. The practices, operational data, and recommended procedures have been derived from the experiences of Transition Landplane Unit, Consolidated-Vultee Aircraft Corporation and the United States Army Air Corps.

This book has been compiled from the pilots' point of view and closely parallels the students' transitional training. In this connection, it has been written to supplement rather than replace any manuals previously published.

This guide can become an invaluable aid in the hands of the serious minded pilot, if he will familiarize himself with the contents. It is hoped that it will be of great assistance to the student pilot, and facilitate his familiarization with the "Liberator" (PB4Y-1) type aircraft.

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Check Pilot..................

STALLING SPEEDS

The following table summarizes approximate stalling speeds for the PB4Y-1 for various combinations of gross weight and wing flap positions.

Gross Weight lb.	Wing Flap Pos.-Deg.	Stalling Speed at Sea Level—MPH Level	30° Bank	60° Bank
43,000	0	107	115	152
Wing Loading	20	94	101	133
(41 lb. Sq. Ft.)	40	80	86	113
50,000	0	115	124	163
Wing Loading	20	101	109	143
(47.7 lb. Sq. Ft.)	40	86	93	122
56,000	0	122	131	173
Wing Loading	20	107	115	152
(53.5 lb. Sq. Ft.)	40	91	98	129

EXAMPLE:

40 lb. Wing Loading, Straight and Level.
64 lb. Wing Loading, 30 degree Bank.
80 lb. Wing Loading, 60 degree Bank.

CHECK LIST

BEFORE STARTING ENGINES

Co-Pilot Reads		Plane Commander Answers
1.	Seat and Rudder Pedals	Adjust
2.	Parking Brake	On
3.	Main Line Switch	On
4.	Battery Switches	On (Off when Battery Cart Used)
5.	Master Heater Switch	Off
6.	Co-Pilot Turret & Defroster Fan Switch	Off
7.	Fire Extinguisher (if installed)	Set
8.	Wing De-Icers	Off
9.	Defroster Switches	Off
10.	Propeller De-Icers	Off
11.	Mixture Controls	Idle Cut-off
12.	Turbo Controls	Off (Stops Released)
13.	Cowl Flaps	Open
14.	Inter-Cooler Shutters	Open
15.	Pitot Heaters and Covers	Off
16.	General Alarm Button	Test
17.	Propellers	High R.P.M.
18.	Trim Tabs	Set for Take-Off
19.	Recognition Lights	Off
20.	Passing, Cockpit, and Landing Lights	As Desired
21.	Running and Formation Lights	As Desired
22.	A.C. Power Switch	On
23.	Wing Flaps	Up
24.	Control Locks	Off (Plane Captain checks controls visually)
25.	A.F.C.	Off
26.	Hydraulic Pressures	Check
27.	Altimeters	Set
28.	Radio	On
29.	Engine Ignition Switches	On
30.	Oxygen System	Check

Co-Pilot Reads		Plane Captain Answers
1.	Wheel Chocks	Removed
2.	Main Power Switch	On
3.	Fuel Valves	On
4.	Amount of Fuel	Gallons
5.	Auxiliary Power Unit	Started

6. Auxiliary Hydraulic Pump ....On
7. Nose Wheel Accumulator or Assembly ....Checked
8. Generator Switches (Radio Man) ....Off
9. Bomb Bays and Hatches ....Secured
10. Flight Controls ....Check

BEFORE TAKE-OFF

Co-Pilot Reads	Plane Commander Answers
1. Flight Controls	Free
2. Turbo Controls	Set
3. Propellers	High R.P.M.
4. Vacuum Pumps Nos. 1 and 2	Check
5. Cowl Flaps	Streamed
6. Wing Flaps	One-Half
7. Trim Tabs	Set
8. Mixture Controls	Auto-Rich
9. Gyro Instruments (D/G and G/H)	Set and Check
10. Booster Pumps	On
11. Hatches	Closed
12. Clocks	Set
13. Radio	Test
14. Hydraulic Pressure (kickout pressure)	Check

BEFORE LANDING

Co-Pilot Reads	Plane Commander Answers
1. Brakes	Check
2. Ignition	Check
3. Wing De-Icers	Off
4. Mixture Controls	Auto-Rich
5. Turbo Controls	Off
6. Cowl Flaps	Closed
7. Inter-Cooler Shutters	Open
8. A.F.C.	Off
9. Altimeter	Set
10. Trailing Antenna (Radio Man)	Reeled In
11. Auxiliary Hydraulic Pump (Plane Captain)	On
12. Nose Wheel Compartment	Check

Final Sequence	During Approach	After Landing
1. Landing Gear	Down	Down
2. Wing Flaps	One Half	Up
3. Propellers	2500 R.P.M.	High R.P.M.
4. Boosters	On	Off
5. Wing Flaps	Full Down	Up
6. Cowl Flaps	Closed	Open

BEFORE LEAVING COCKPIT

Co-Pilot Reads	Plane Commander Answers
1. Parking Brakes	On (Unless Chocks Used)
2. Battery Switches (After instruments return to zero)	Off
3. Main Line Switch	Off
4. A.C. Power Switch	Off
5. Radio	Off
6. Controls	Locked
7. Landing Gear Lever	Down
8. Ignition Switches	Off

POWER PLANT OPERATION

I Take-off Sea Level—1200 h.p., 5 minutes duration:

- (a) Mixture Controls .... Auto-Rich
- (b) R.P.M. 2700
- (c) Manifold Pressure .... 49" Hg
- (d) Fuel Pressure .... 14—16 PSI
- (e) Oil Pressure........80 PSI Minimum, 100 PSI Maximum.
- (f) Oil Temperature....40° C. Minimum, 95° C. Maximum
- (g) Cyl. Head Temp.....150° C. Minimum, 260° C. Maximum

Desired Oil Pressure—Approximately 95 PSI.
Desired Oil Temperature—75° C.—85° C.
Do not start take-off with cylinder head temperature above 205° C.

II Military Rating—From sea level to 23,400 feet—1200 h.p., 5 minutes duration:
All limits same as for take-off.

III Normal Rated Power—From sea level to 25,000 feet, 1100 h.p., continuous operation:

- (a) Mixture Controls .... Auto-Rich
- (b) R.P.M. 2550
- (c) Manifold Pressure .... 45.5" Hg
- (d) Fuel Pressure .... 14—16 PSI
- (e) Oil Pressure........80 PSI Minimum, 100 PSI Maximum
- (f) Oil Temperature .... 95° C. Maximum
- (g) Cyl. Head Temperature....260° C. Maximum for 1 hour
  232° C. Maximum continuous

Desired Oil Pressure—Approximately 90 PSI.
Desired Oil Temperature—75° C.—85° C.
Desired Cyl. Head Temperature—220° C.—230° C.

IV Cruising Power:

1. Carburetors, Auto-Rich—Sea level to 31,000 feet, 75% Normal rated power, 825 h.p., continuous.
   - (a) R.P.M. .... 2325 Maximum
   - (b) Manifold Pressure .... 35.5" Hg Maximum
   - (c) Fuel Pressure .... 14—16 PSI
   - (d) Oil Pressure .... 85—95 PSI
   - (e) Oil Temperature .... 75° C.—85° C.
   - (f) Cyl. Head Temperature .... 232° C. Maximum
2. Carburetors Auto-Lean—Sea Level to 33,000 feet, 65% normal rated power, 715 h.p. continuous.
   - (a) R.P.M. .... 2200 Maximum
   - (b) Manifold Pressure........32" Hg Maximum
   - (c) Fuel Pressure .... 14—16 PSI

(d) Oil Pressure ....85—95 PSI
(e) Oil Temperature ....70° C.—80° C.
(f) Cyl. Head Temperature ....232° C. Maximum
(g) BMEP not to exceed 140 PSI in Auto-Lean.
Listed readings of oil pressures and temperatures are normal readings. Readings slightly above or below these limits will not cause damage.
Desired cylinder head temperature—200° C.

V War Emergency Rating 1350 h.p. for 5 minutes.
(a) Water injection equipment.
(b) R.P.M. 2700
(c) Manifold Pressure ....57" Hg.
(d) Not installed as yet—No operating instructions available.

VI Starting and Stopping Engines:

1. Starting Engines:
(a) All switches off.
(b) Props pulled through by hand (6 blades).
(c) Turbo Controls off (see that waste gates are open).
(d) Carburetors—Idle cut-off.
(e) Fuel Valves—Tank to engine (on).
(f) Master battery switch on, main power switch (bar switch or crash switch) on, battery switches on—Start Putt-Putt (APU)*.
(g) Turn on auxiliary hydraulic pump—Set brakes, wheels chocked.
(h) Cowl flaps open.
(i) Propellers—High R.P.M.
(j) A.C. Power switch on—Ignition switches on.
(k) Throttles, 1/4—1/3 open.
(Start engines electrically in order of 3-4-2-1).
(Start engines manually in order of 1-2-3-4).
(l) Booster on—On engine to be started.
(m) Energize starter—15-20 seconds.
(n) Prime while energizing, 7-8 shots cold, 4-5 shots warm, then booster off.
(o) Release energizing switch, engage meshing switch.
(p) As soon as engine fires, put mixture control in auto-lean. If engine does not run immediately put mixture control back in idle cut-off.
(q) When engine is running watch oil pressure gauge. If no oil pressure registers within 30 seconds, stop engine.
(r) Warm up at 1000—1200 r.p.m.

*When using battery cart do not turn on battery switches or putt-putt.

2. Stopping Engines:
   (a) Turn up engines to 800—1000 r.p.m.
   (b) Check mags, switch from "R" to "L" and back to both. This is not to check drop-off, but to check for possible dead mags.
   (c) Place carburetors in idle cut-off.
   (d) When engines have stopped firing, slowly open the throttles.
   (e) After engines have stopped turning, turn off ignition switches.
   (f) When engine instruments have returned to zero, turn off A.C. power switch.
   (g) Turn off battery switches, then main power switch.

NOTES:

1. The amount of prime needed is a matter of experience.
2. Starting engines in auto-lean applies only to PB4Y's equipped with R-1830-43 engines. These engines are equipped with Stromberg carburetors which require auto-lean for all ground maneuvering. PB4Y's equipped with R-1830-65 engines are to be started in auto-rich, and all ground maneuvering done in auto-rich.** The R-1830-65 is equipped with a Chandler-Evans carburetor. The only difference between the R-1830-43 and the R-1830-65 engine is the carburetor. All PB4Y's equipped with R-1830-43 engines have throttle stops. Those equipped with R-1830-65 engines may or may not have throttle stops.
3. When starting cold engines it is important to watch the oil pressure gauge as soon as the engine fires, because oil pressures attained with cold oil are such that the pointer will go all the way around the dial and will indicate little or no oil pressure, when actually it is upwards of 200 PSI. As the oil warms up the pointer will slowly drop back to about 140 PSI. At this point the oil pressure thermostatic relief valve opens and the oil pressure drops to normal.
4. Do not cut engines with cylinder head temperature above 205° C.

**All ground maneuvering in auto lean if carburetor jets have been changed as required. Until jets have been replaced do not exceed 12,000 feet.

FLIGHT TEST PROCEDURE
(NEW ENGINES)

The following is recommended as the procedure to be followed for testing new engine installations in PB4Y-1 type aircraft.

A. Before starting engines:
   1. Follow regular check-off list.
   2. Test operation of cowl flaps—closed and open.
   3. If everything is in order according to plane captain, start engines.

B. After starting engines:
   1. Warm up thoroughly; Auto-lean, R-1830-43; Auto-rich, R-1830-65.
      (a) Head temperature (cylinder) 150° C. minimum.
      (b) Oil temperature 60° C. minimum.
      (c) Oil pressure 50—70 PSI at 1000 r.p.m.

C. Check propeller feathering—4, 3, 2, 1.
   1. When ground feathering is done, do not cut any engine, leave it running.
   2. Carburetor in Auto-rich on engine to be checked. Turn up to 1700—1800 r.p.m. Feather propeller.
   3. R.p.m. will drop to 450—550. Unfeather as soon as possible to avoid excessive cylinder head temperature. Engine may smoke considerably when feathered.
   4. When unfeathered—Carburetor in Auto-lean; R-1830-43 only.

D. Engine run up:
   1. Auto-rich all four engines.
   2. Run up to 1500 r.p.m. Check flaps; down-up. Exercise propellers at least twice. Check fuel pressure rise or fall with booster pumps on, then off.
   3. If cylinder head temperature rises above 205° C. when exercising propellers, allow to cool below 205° C. before proceeding further.
   4. Check mags and set turbos. Auto-rich on engine being checked.
      (a) Two thousand r.p.m., approximately, 26″ Hg M.P. Check mags; allowed—no more than 100 r.p.m. drop per mag, if engine runs smooth; desired—no more than 80 r.p.m drop.
      (b) Open throttle to stop, 2400—2500 r.p.m; 36—38″ Hg M.P.
      (c) Set turbo to 45.5″ Hg M.P. R.p.m. rises to 2600—2675. Oil pressure not to exceed 105 PSI, 95 PSI desired, fuel pressure 14—16 PSI.

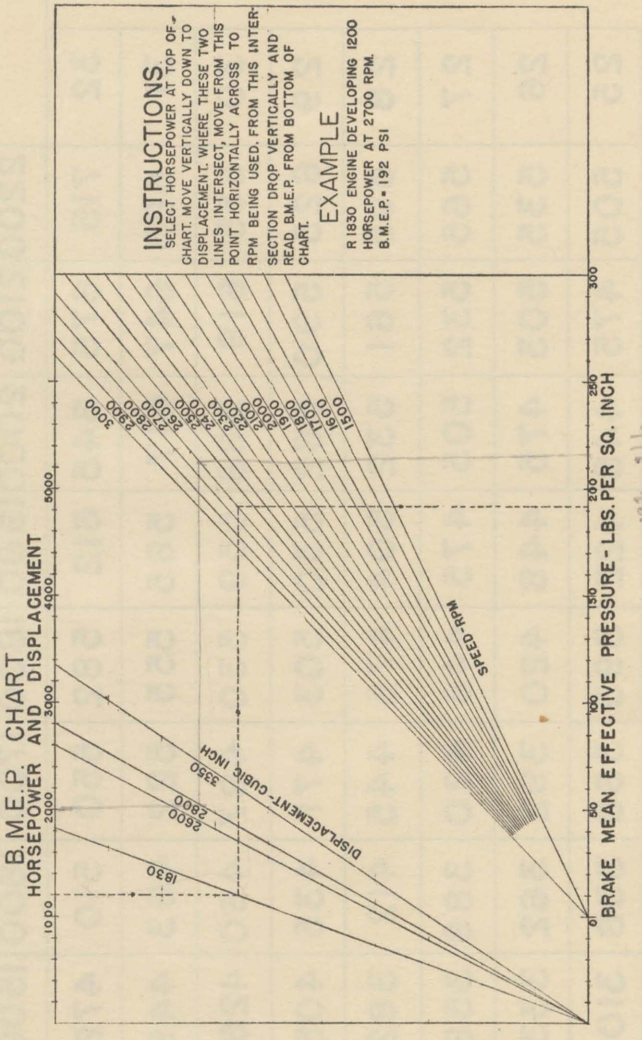
E. Take-off and climb—Auto-rich:
  1. Twenty-seven hundred r.p.m.; 45.5″ Hg M.P.
  2. When airborne 2500 r.p.m., 44″ Hg. Gear up, flaps up, turbos off.
  3. Climb—2250 r.p.m., 32″ Hg to 7000 feet altitude noting any rough engine operation.
     (a) Record engine instrument readings during climb. Cylinder head temperature 232° C. maximum.
     (b) Oil temperature approximately 80° C. (100° C. maximum).
     Oil Pressure, 85—95 PSI.
     Fuel Pressure, 14—16 PSI.
  4. Turbos may have to be used to obtain 32″ Hg M.P. at 7000 feet altitude.

F. Level Flight:
  1. Leave 2250 r.p.m., 32″ Hg Auto-rich, level off at 7000 feet. Boosters off, cowls closed.
  2. Run five minutes to allow temperatures and pressures to stabilize and record engine readings.
     (a) Cylinder Head Temperature........232° C. Maximum.
     (b) Oil Temperature ....75°—80° C.
     (c) Oil Pressure ....85—95 PSI
     (d) Fuel Pressure ....14—16 PSI
  3. Check fuel pressure rise or fall with boosters on, then off.
  4. If turbos are being used, turbos off, change to 2100 r.p.m. Reset turbos to 32″ Hg. After five minutes record engine readings, approximating those above.
  5. Leave 2100 r.p.m., 32″ Hg, change to Auto-lean.Run five minutes and record engine readings, approximately same as above. Do not exceed 32″ Hg M.P. in Auto-lean.
  6. Turbos off, change to 1900 r.p.m., reset turbos to 31″ Hg M.P. Run five minutes and record engine reading, approximately same as above.
  7. If everything OK, run at 1900 r.p.m. 31″ Hg for at least two hours, if possible. Adjust cowl flaps to maintain 200° C. cylinder head temperature (maximum).
  8. During run at 1900 r.p.m., 31″ Hg set throttles to 29″ Hg, if possible. Run M.P. to 31″ Hg with turbos.
  9. Check for rough engine operation during all tests.

G. Final Test:
  1. Auto-rich, boosters on, 2550 r.p.m., 45.5″ Hg, cowls closed. Run five minutes and record engine readings.
     (a) Cylinder Head Temperature........260° C. Maximum.
     (b) Oil temperature ....90° C. Maximum
     (c) Oil Pressure ....105 PSI Maximum.

(d) Fuel Pressure ....14—16 PSI

This completes test, return to base, recording all discrepancies.



HORSEPOWER CHART

MAN. PRESS. IN. OF HG.	R.P.M. 2200	2100	2000	1900	1800	1700	1600	1500
32	715	675	645	612	582	550	510	472
31	685	647	617	585	555	522	483	449
30	655	619	588	559	530	497	460	426
29	625	590	562	530	503	471	435	405
28	595	561	532	504	475	445	412	382
27	565	532	505	475	448	420	388	358
26	535	503	475	448	420	392	362	333
25	505	475	448	422	393	368	338	310
24	475	448	421	395	367	343	314	289

SYNCHRONIZATION OF PROPELLERS

Proper propeller synchronization is very important in any type of multi-engine plane. Tachometers alone cannot be used for synchronization since a small amount of error is present in all instruments.

1. Synchronization is accomplished by use of the senses of sight, hearing, and feel. Tachometers are used to indicate r.pm. so bring all tachometers to same setting.

2. Each outboard propeller is synchronized to the inboard propeller on its side of the plane by observing the shadow caused by the blades. If propeller governor control switches No. 1 and No. 3 are used for the port and starboard sides, respectively, an easily remembered system can be used. If the shadow is moving inboard pull the control switch back, if the shadow is moving outboard push the control switch forward.

3. To finally synchronize the two pairs of propellers, operate **both** the switches controlling the propellers on **one side** of the plane until the beat set up between the two pairs of propellers disappears, by **sound only.**

4. To properly synchronize all propellers, it is necessary that all engines be operating under the same condition of mixture, power, etc.

5. At night use flashlights or landing lights to see shadows.

FEATHERING PROPELLERS

The following instructions should be applied in flight:

1. Emergency Feathering:
   - (a) Trim aircraft for level flight, holding altitude. Close propeller feathering switch.
   - (b) Close throttle.
   - (c) Move mixture control to "Idle cut-off" position.
   - (d) Leave ignition switch on until propeller stops, then turn off.
   - (e) Close cowl flaps.
   - (f) Check vacuum, if No. 1 or No. 2 engine out. (No. 3 engine out, start auxiliary hydraulic pump and open star valve).
   - (g) Turn off fuel valve.
   - (h) Turn off generator switch.
2. Practice Feathering:
   - (a) Trim aircraft for level flight, holding altitude. Retard throttle.

(b) Reduce r.p.m. to minimum.
(c) Place mixture control in "Idle cut-off" position.
(d) Close propeller feathering switch.
(e) After propeller stops, turn ignition switch off.
(f) Close cowl flaps.
(g) Check vacuum, if No. 1 or No. 2 engine out. No. 3 engine out, start auxiliary hydraulic pump and open star valve.
(h) Turn off fuel valve.
(i) Turn off generator switch.

3. Unfeathering:
(a) Turn on fuel valve and generator switch.
(b) Turn on ignition switch.
(c) Check propeller in minimum r.p.m.
(d) Set mixture to Auto rich position for starting (if cylinder head temperature is low, place in Auto-lean for warm up after starting), when propeller reaches 800--1000 r.p.m.
(e) Crack throttle.
(f) Close propeller feathering switch.
(g) Keep switch closed until tachometer indicator reads 800---100 r.p.m., then release.
(h) After required temperature is reached, adjust to desired power.
(i) Check Star Valve in case of No. 3 engine.
(j) Warm up:
Under 100° C. use 15" Hg.
Between 100° C. and 150° C. use 20" Hg.
Over 150° C.—Normal operation.

EMERGENCY FLIGHT OPERATIONS

ENGINE FAILURE

ENGINE FAILURE ON TAKE-OFF—In the event of engine failure on take-off, the pilot must immediately choose between two alternatives. The proper choice will be determined by the conditions prevalent at the time of the engine failure.

1. If an engine fails before the landing gear is up and there is sufficient runway left to land the airplane, the proper procedure would naturally be to throttle the remaining engines and effect a landing; if a landing cannot be accomplished, as stated above, and continued flight is not advisable due to further mechanical trouble, atmosphere or load conditions, or a combination of the above, the procedure would be to throttle back and land straight AHEAD on the wheels, if a proper field was available, or wheels UP if the field were rough.

Caution—In the event of a belly landing, use full flaps and sufficient airspeed to avoid a high rate of sink.

2. In the event the airplane is going to be flown, which is generally the case, FIRST, fly the airplane by getting the nose down to the minimum angle of climb required to safely clear any hazards or obstructions. Immediately follow by using enough rudder and aileron to counteract the yaw created by the unbalanced power condition. The landing gear should be raised as soon as practical to reduce drag. At this point, the trim tab should be applied to relieve the physical effort required on the controls. Next, DETERMINE POSITIVELY WHICH engine is at fault by observing: (1) engine temperature; (2) manifold pressure; (3) tachometer reading (r.p.m.); (4) yaw of the airplane. Then feather the propeller. Follow by turning off the magneto switches and valve of the engine at fault. At a safe altitude, raise the wing flaps in three or four stages to avoid high rates of sink, under most conditions retaining 5° of flaps is desirable.

3. Do not draw excessive power from the remaining engine for a longer period than necessary to get the airplane under safe control.

4. Do not fail to use sufficient rudder in trimming the ship. Carry the dead engine wing high only the amount necessary to make directional control possible. Insufficient rudder and too much aileron will cause the airplane to be flown in a forward slip, making it impossible to attain a safe airspeed.

5. Do not try to apply trim tabs while applying rudder and aileron. First, introduce the required amount of rudder and aileron. Hold it, then, relieve the strain with tabs.

6. Do not forget that it is always desirable to keep dead engines high on all turns.

7. Do not fail to attain and hold a safe airspeed. A minimum of 135 m.p.h. with 20 degrees of flap and 145 to 150 m.p.h. with a zero to five degree flap setting under normal load conditions.

8. Do not forget, engines number one and two are equipped to furnish the vacuum and pressure for the gyro instruments and de-icer boots; that number three engine drives the hydraulic pump. In the event that any of these engines are feathered, switch to the alternate source of supply.

9. In the event a propeller refuses to feather, check the circuit breaker. If this is not at fault, put the propeller in low r.p.m.

FAILURE OF TWO ENGINES IN FLIGHT.

1. With two engines on one side inoperative, it is possible to fly the airplane in all normal maneuvers within the engine power limits.

2. When the two operating engines are delivering rated power, it is desirable to bank the airplane (dead engines high) to reduce the rudder pressure required for straight flight.

3. The service ceiling with left engines running, and both right engines dead and propellers feathered, will be slightly higher than the ceiling with right engines running, left engines dead. In all cases the ceiling with any two engines dead and a gross weight of 41,000 pounds is above 10,000 feet.

4. Airplanes with one engine out will generally maintain altitude with the landing gear extended. When only two engines are useful, the airplane cannot be expected to maintain altitude with both landing gear and flaps extended.

LANDING WITH ONE OUTBOARD ENGINE INOPERATIVE.—The following is recommended:

1. Keep the dead engine high on all turns near the ground.

2. Fly the traffic pattern at least 500 feet higher than customary.

3. Place the base leg close enough so a minimum amount of power is required on the final approach. At the point power reduction is required, instead of partially reducing power on all three active engines together, reduce power on the active outboard to about twelve inches manifold pressure. Then, use the inboard engines for power, the same as a twin-engine aircraft. Just before landing, close the active outboard throttle with the inboards. If the above procedure is used, the check list for landing can be followed closely in regard to flap settings, landing gear, high r.p.m., etc. Also, on the final approach, a normal tab setting is possible.

Caution—Avoid any high rates of sink on the final approach unless you have excessive air speed, due to the reduced available power.

If runway length permits, use 5 to 10 m.p.h. higher airspeed than customary on the final approach.

LANDING WITH TWO ENGINES INOPERATIVE ON ONE SIDE.—Approach the traffic pattern high enough to permit the pattern to be flown with a minimum amount of power; in other words, a semi-glide condition all the way in to the actual landing, reducing power on the active outboard engine first. Other than having more altitude in the traffic pattern necessary due to the lack of available power and the off-balance power condition existing which makes it undesirable to pull a high amount of power from the active outboard engine, proceed the same as landing with one outboard engine inoperative.

LANDING WITH ONE ENGINE INOPERATIVE ON EACH SIDE.—Use the same method as landing with two engines inoperative on one side, even though the inoperative engines should be an inboard on one side and an outboard on the other. This condition is easier to control due to power available on each side.

Note—When flying across country with one or more engines inoperative, it is necessary to maintain sufficient airspeed to properly fly the airplane. Under normal load conditions a minimum of 150 m.p.h. with no flaps and 145 m.p.h. with ten degrees of flap is recommended. Under a condition where the available power is not sufficient to maintain altitude, it is usually possible to reduce the sink two or three hundred feet a minute by using ten degrees of flap and an airspeed of about 145 m.p.h.

Note—If the approach to the traffic pattern, the traffic pattern itself, and the final approach leg are PROPERLY PLANNED, a pilot with average ability can land the airplane with one or two engines inoperative. The less the power required on the live engines with unbalanced power, the less severe the off-trim condition; thus the recommended semi-glide base and final approach leg. To acquire this, more altitude in the traffic pattern and a close base leg is required.

1. WIND MILLING AN OUTBOARD ENGINE ON TAKE-OFF.

1. When off the ground and at a point where the airplane must be flown out and not landed again on the remaining runway, pull either number 1 or 4 throttle completely off. Have the student fly the airplane by first getting the dead engine wing up and coming in with sufficient **rudder** to fly the airplane in a straight flight path, paralleling the runway. After this has been accomplished trim tab may be applied, then the gear is raised when safe to do so, followed by making the flaps up in stages; to make the student aware of the necessity of feathering dead engine. Have him tell at what point he would feather on the

take-off, and what engine. Have him tell you this during the actual performance. He should be so instructed before the take-off. At the point the student states he would feather, open the throttle on engine in question to 12 H.G. This simulates the drag of a feathered engine at 150 m.p.h. airspeed.

Common Errors are:

(a) Failure to get the wing up high enough.
(b) Failure to get the wing up soon enough.
(c) Not first flying the airplane and getting it under control, before setting trim tabs.
(d) Failure to choose the right point to raise the gear.
(e) Feathering engines before being positive which engine is at fault.
(f) Not raising the flaps in several stages.
(g) Not using enough rudder.

2. CLIMB.

1. The climb should be made at the highest airspeed, that maximum rate of climb is obtainable usually 150 to 160 miles per hour. The r.p.m. should normally be 2250 r.p.m. The power setting from 41 to 45 inches H.G. Cylinder head temperatures pretty much control the power setting. If an excessive cowl flaps setting is required at 45 inches, lower the H.G. setting to 42 or 43 inches.

3. CRUISE.

1. It is recommended that two inches of Turbo be used at altitudes where it is possible to get the desired H.G. with throttles alone. Above this altitude desired power is obtained with Turbos. Remember on reducing power, always reduce manifold pressure first, then r.p.m. When adding power, first increase r.p.m., then increase manifold pressure.

4. FEATHERING.

1. Feather both engines on one side, have the student trim the ship hands off. At this point make turns away from the dead engines, and into the dead engines. Thirty degree banks into the dead engines is possible at altitude, but not recommended at low altitudes. Maintain an airspeed of 150 miles per hour. Tell the student if he were actually making a landing with two engines feathered on one side, he should request a traffic pattern that would keep the dead engines up on all turns. This is also desirable with an outboard feathered and if not possible to make shallow turns into the dead engines.

2. Demonstrate the required power necessary to maintain level flight with two engines feathered on one side. Now feather the other

outboard engine, flying on No. 3, engine pulling 45 inches H.G. and 2550 r.p.m. At 140 to 145 miles per hour have him note the rate of sink, then apply ten degrees flap under the above condition. A minimum sink of from three to five hundred feet is possible with a 43,000 lbs. gross weight. When feathering more than two engines be sure the active engine has a good generator and start the APU before feathering. Also when unfeathering do not exceed 20 inches H.G., until head temperature reaches 150 degrees.

5. DEMONSTRATING DRAG BETWEEN WIND MILLING AND FEATHERED ENGINE.

1. First windmill an outboard, then have the student trim the ship hands off. When this has been accomplished feather this engine, calling the student's attention to decrease in drag by the swing of the airplane's nose. This can also be demonstrated by doing the above, but instead of trimming the ship, holding the drag physically, then feeling the reduced drag when feathered. The above is to impress the student with the benefit of feathering a faulty engine.

6. STALLS.

1. At 25 H.G., no flaps, have the student stall the airplane. At the first indication of a burble lower the nose, keeping the wings level with the **rudder** only. Have the student note the airspeed, the airplane stalls from 105 to 110 miles per hour usually. Next, do the above with half flaps. Stalling speed will be 90 to 95 miles per hour. Next repeat the above with full flaps, the stalling speed will be about 80 to 85 miles per hour. Next repeat the full flaps stall with gear down. Note the stalling speed will be about the same, but is more quickly acquired. Also it takes longer to obtain flying speed due to the drag of the gear. Do not exceed 150 miles per hour with flaps or gear extended (on emergency O.K.).

2. With gear and flaps retracted do a power-off stall having the student note the high rate of sink and loss of altitude on the recovery, as well as steep angle of recovery necessary to obtain flying speed, and the ease of producing a secondary stall by too fast a recovery. The airplane stalls power off, at about 115 miles per hour, no flaps. If desired flaps setting, and gear down, stalls may be demonstrated. The result will be a longer time required to acquire flying speed.

3. One of the partial power stalls as well as the power off stall, should be done with power recovery, to demonstrate the resultant reduced sink and loss of altitude. Note the above quoted stalling airspeeds are maximum obtainable, with properly calibrated airspeed

meters, and good flying technique. It is not necessary to acquire the above reading.

4. The purpose of the stall is to teach the student to sense the first indication of the stall, and a proper method of recovery.

7. SIMULATED ENGINE FAILURE TAKE-OFFS.

1. At a safe altitude and 25 H.G. have the student put the airplane in a moderate climb. When the airspeed reduces to 150 miles per hour give him half flaps, continue the climb to 125 miles per hour, at which point pull both throttles on one side completely.

2. He should be given this maneuver until he is able to recover within ten degrees of the original heading. The proper method of recovery is to get the nose down, get the dead engine wing up, and come in with full **rudder**.

3. After the first couple of attempts have the student conscious of the possible need for more power. For practice make him open the throttles on the two active engines, explaining that if the engine failure occurred on take-off, the throttle would be open, so the added power if needed would be obtained by pushing the turbo levers forward, collapsing the spring loaded emergency stops.

4. Common errors are:
- (a) Not acting quick enough, thus allowing the ship to get in a compromising position.
- (b) Not getting the dead engine wing high enough.
- (c) Not holding the dead engine wing high.
- (d) Failure to use enough **rudder**.
- (e) Trying to recover in a nose high attitude.
- (f) The other extreme, not trying to recover with a minimum loss of altitude, by over diving and acquiring too much airspeed. 130 to 135 miles per hour is sufficient airspeed, or forgetting the necessity of more power.

8. DISCOURAGING STEEP TURNS NEAR THE GROUND.

1. Have the student fly the airplane in a 30 to 35 degree bank, then cut the throttles on both the low engines.

2. Have him recover to straight flight with a minimum loss of altitude. This maneuver should be done with no flaps.

9. THREE (3) ENGINE LANDINGS.

1. In the traffic pattern completely close the throttle on the outboard engine, that will be the high wing on all turns in the pattern. It is recommended that the airplane is not trimmed completely hands

off, due to the excessive off trim condition that will later develop on the final approach, when the throttles are reduced for landing.

2. The easiest way to execute a three engine landing when an outboard is out, is to place the base leg close enough, and be high to be able to pretty much throttle the active outboard, so the final approach can be made with the inboard engines, thus relieving the off trim condition.

3. **Note**—Avoid high rates of sink at low airspeeds, when relying on two engines. A slightly higher airspeed on the final approach is desirable if the runway length permits it.

TAXIING

When taxiing it is imperative that application of brakes, rudder and throttle be coordinated in such a manner as to keep the plane taxiing in a straight line not in excess of 15 m.p.h. and without excessive use of throttle at any time. Unless in cases of emergency use of throttle in excess of 1400 r.p.m.'s is unnecessary. Apply gentle pressure on brakes at all times and slow plane to below 15 m.p.h. when making turns.

At all times try and taxi without use of brakes using outboard engines and rudder where applicable. The secret of taxiing a PB4Y-1 type of aircraft is the proper use of outboard throttle and the minimum use of brakes, always taxiing at such a speed so as to have complete control of the aircraft on the ground.

Remember, use only one outboard engine at a time, and be sure to cut back all throttles when braking plane to a complete stop. This is important for proper consideration of your brakes and nose-wheel assembly may some day mean the saving of not only your own life but those of your crew as well.

HELPFUL HINTS IN TAXIING

1. Keep tower controlling field posted as to your movements.
2. Is your plane captain on lookout from Pilots Escape Hatch?
3. Is Second Pilot closely watching starboard side of plane?
4. Are your booster pumps off, Mixtures Auto-lean, and cowl flaps open?
5. Never at any time spin plane on inboard side mount. **Remember** there is a rubber shortage.
6. Do not cock nose-wheel more than 30° at any time.
7. When braking to a complete stop and nose-wheel starts to turn either to right or left, release pressure on brake on side to which nose is turning and catch with opposite brake.
8. Refrain from using excessive amounts of outboard throttle when taxiing as the only result will be the jockeying of the plane up the taxiway.
9. When parking brake is on and engines are turning up at 1000 r.p.m.'s and parking brakes are released, leave engines turning up at 1000 r.p.m's until forward motion is obtained, then throttle back using outboard throttles to guide forward path of plane.
10. **Remember** that bouncing of the planes nose section is due to excessive use of brakes and is a glaring example of an inexperienced pilot.

35" } Climb
2300 }

NORMAL OR 1/2 FLAP (20°) TAKE-OFF

I Prior to taking the runway, the pilot will use the "seven (7) point" check-off system ie:

1. Turbos set and on
2. High R.P.M. (Lights checked)
3. Tabs set
   a. Elevator tab (2° nose up)
   b. Rudder tab (2°-4° right rudder)
   c. Aileron tab (0 or as required)
4. Flaps at 1/2 or 20°
5. Cowl flaps streamed (3°-5° open)
6. Mixture in auto rich
7. Booster pumps on

II Clearance for taking the runway:

1. Tower if required
2. Plane captain's "all clear"
3. Co-pilot's "all clear"

III Take-off position:

1. Down wind as far as possible
2. Center of runway

IV Take-off:

1. Hold brakes until 25" H.G. is obtained
2. Release brakes (shift feet off brakes to rudder pedals)
3. Steer plane with engines and rudders while drawing throttles for max. H. P.
4. Co-pilot adjust lock nut for throttle security
5. At 80 M.P.H. raise nose wheel off the deck
6. Place plane in an attitude that will allow it to become air borne at 115-120 M.P.H.
7. Between 50 - 100 ft. hit brakes - gear up
8. Initial power reduction 45" Hg—2500 r.p.m.*
9. Maintain 140 M.P.H. with 1/2 flaps
10. After wheels are retracted, flaps up, speed 150 M.P.H.
11. Turbos off, 35" Hg—2300 r.p.m.
12. At 1500 feet check nose wheel compartment
13. Maintain above settings until 1900 feet altitude is reached then:
    Wheels down
    31" - 2100
    Boosters off.
    Cowl flaps closed
14. After wheels are checked by the plane captain, pilot checks brake pressures.

* Using	91	octane	gas	42.5″ Hg - 2750 r.p.m.	for T.O.
”	”	”	”	40.0″ Hg - 2500 r.p.m.	(Initial power reduction)
”	”	”	”	38.0″ Hg - 2500 r.p.m.	(Maximum for climb)
”	”	”	”	35.0″ Hg - 2300 r.p.m.	(Normal for climb)

NO FLAP TAKE-OFF

I Take-off settings, position, and clearance same as for normal take-off, except use no flaps.

II Take-off:
Identical to normal take-off except plane requires longer run, higher take-off speed, (130 M.P.H.) slightly higher nose altitude. Climb at 150 M.P.H. remainder of take-off the same as a normal take-off.

FULL FLAP (40°) TAKE-OFF

In case it is necessary to take-off from an exceptionally short field and to clear rather high obstructions that are in close, a full flap take-off should be used. It will place the plane in the air faster with a shorter run than any other method. It must be noted, however, that the airplane is in a dangerous attitude in case of engine failure. When using this method, it is highly recommended that the plane be made as light as possible.

1. A full flap take-off differs from the conventional 1/2 flap or normal take-off in the following manner:
   (a) Prior to taking runway, place elevator tab in full nose-up position.
   (b) Start take-off run with half flaps. As soon as throttles are set and tightened, drop flaps full down (40°).
   (c) A decided back pressure is necessary to take the plane off at approximately 90-100 m.p.h.
   (d) Hold 100 m.p.h., climb to 200-300 feet altitude to clear obstructions, nose over gradually holding your altitude and pick up speed to 127 m.p.h.
   (e) Bleed flaps to half, wheels up, then proceed the same as for normal take-off.

THREE-ENGINE TAKE-OFF

Three engine take-off is accomplished as follows:

1. The two symmetrical good engines are operated in the same manner as for normal take-off.

2. Rudder tab is adjusted to give the maximum possible force to counteract the unsymmetrical thrust.

3. During the take-off run the rudder is held over as far as possible and power of the odd engine increased as the force on the tail becomes greater, thus keeping the ship straight.

It has been found that with an outboard engine stopped, and its propeller feathered, the other outboard may be allowed to develop approximately 750 H.P. (2500 R.P.M. and 30" Hg) at take-off. In case an inboard engine is dead, the other inboard can be allowed to develop practically 1200 H.P. (full take-off power) by the end of the take-off run.

Tests show that, with an outboard engine dead, the take-off run is from 2¾ to 3 times as long as when using all four engines. With an inboard engine dead, the run will be 2 to 2¼ times as long as that required when all engines are used.

If time and facilities permit, removal of the propeller and closing the front of the dead engine will reduce drag and improve performance.

OVERSHOOTING FIELD OR POWER PULL-UP

In case of overshooting the field or refusing a landing for any reason the following prcedure is necessary for the pull up:

1. Apply full throttle. If additional power is needed use the turbos. Hold throttles forward.

2. Order "bleed flaps up one-half" if airspeed is over one hundred and twenty-seven (127) miles per hour.

3. Raise landing gear after the flaps are up to one half.

4. Order "flaps up" as soon as gear is up and airspeed reaches on hundred forty (140) miles per hour.

5. Order "cowl flaps streamed."

6. Climb to approach altitude (150 M.P.H.).

7. Reduce power setting as on normal take-off.

8. If plane has touched runway, "Flaps to half" before plane is airborne, instead of "Bleed flaps to half."

NORMAL LANDINGS

(Procedure as listed will be used for continuous practice landings. (If returning from extended flight, have second pilot run through complete check list prior to entering landing circle). Airspeeds indicated are for normal loads.

1. Lower landing gear after slowing plane to 150-155 m.p.h., maintain constant airspeed.

2. Desired altitude for base leg is 1500 feet, course rules permitting. Base leg is parallel to runway, downwind, sufficiently wide that the field appears just under the wing tip.

3. Order "Half-flaps," with airspeed 150-155 m.p.h. before maneuvering for approach. Ideal position is on base leg, 1500 feet altitude with beginning of runway directly a beam. Maneuvering airspeed 140 m.p.h. with flaps ½ down.

4. With flaps ½ down, airspeed 140 m.p.h., reduce throttle for steady rate of descent while maneuvering for approach. Normal setting 24 to 26 inches manifold pressure twenty-one hundred (2100) r.p.m.

5. With the field slightly on the quarter, begin and hold a steady turn until aligned with the runway. The turn should be so judged that an ample distance and altitude is allowed for the final approach (800-100 feet altitude and one to one and half minutes away).

6. Order "Boosters on."

7. Order propellers "2500 r.p.m."

8. Order "Full Flaps" when needed before landing (Recommended lowering just prior to straightening out on final approach. Maneuvering airspeed 130 m.p.h. with full flaps down."

9. Maintain airspeed 130 m.p.h. until throttle is slowly reduced and levelling off started for final landing. Level off low and land in slightly nose up position. Hold sufficient back pressure on the yoke to keep the nose wheel off the mat until plane has slowed down. Do not drag tail skid.

10. After landing has been completed order: (a) "Auto Lean" (b) "Booster Pumps Off" (c) "Cowl Flaps Open," and after slowing down (d) "Wing Flaps up."

NOTE: 1. Prior to lowering gear ask the plane captain, "Nose wheel compartment clear?"

2. Immediately upon lowering gear check brakes by application then check accumulator pressures prior to landing.

FULL FLAP NO POWER LANDING

The procedure for a Full Flaps no Power Landing is as follows:

1. Make the approach turn following the regular pattern except that two thousand (2,000) feet altitude is desired at the point on the final approach, throttle is removed completely. The final glide begins.

2. Push the nose and take throttle off completely; blimp the engines occasionally during the final descent to avoid fouling the plugs.

3. Maintain one hundred thirty five (135) miles per hour for the glide. (This speed will permit a normal flare, leveling off and landing without the danger of mushing as the glide is broken.)

NOTE: With flaps deflection of twenty degrees (20°) the wing lift increases twenty four percent (24%) but the drag increases thirty percent (30%).

With flap deflection of forty degrees (40°) the wing lift increases fifty five percent (55%), but the drag increases seventy seven percent (77%).

CLOSED FIELD OR LOW VISIBILITY APPROACH AND LANDING

1. Approach is started when over field, contact flight. Ceiling 500', visibility not more than one mile.

2. Turn upwind, keeping field in sight at all times. Airspeed 155 m.p.h., lower wheels.

3. Turn down wind, keeping within sight of field (1 mile). Lower flaps to 20°, speed 140 m.p.h.

4. Auto rich, booster pumps on, 2500 r.p.m., lower flaps to full, speed 130 m.p.h.

5. When end of runway is abeam, start into final approach, maintaining 130 to 135 m.p.h. in turn. Aim at inside corner of runway.

6. Proceed with normal landing.

SMALL OR SHORT FIELD APPROACH

Procedure for small field approach may vary considerably depending upon operating conditions, load, obstruction to be cleared, etc. The procedure listed is for normal conditions as exist in training.

1. Initial part of approach with half flaps is the same for normal landing. If desired, lose a little more altitude in the turn so that a smaller rate of descent may be used for the final approach.

2. Straighten out final approach 1 to 1½ minutes away from field, altitude 600-800 feet, using full flaps down, booster pumps on 2500 r.p.m. During first half of final approach maintain 130 m.p.h. and decrease altitude slowing plane first to 120 M.P.H. and gradually down to 110-115 M.P.H. after clearing final obstructions, using plenty of throttle so that the plane is hanging by the propellers in a nose high altitude.

3. As soon as the throttles are taken off, the plane will drop immediately. With this in mind, cut the throttles just as you reach the field at a minimum clearance from the ground. Hold the nose up, land, and proceed in the normal manner.

DEMAND FLOW OXYGEN SYSTEM

I GENERAL SYSTEM:

A. 24 G-1 low pressure (400 PSI) bottles (2100 Cu. In.)

B. 2 D-2 low pressure (400 PSI) bottles (500 Cu. In.)

C. 12 low pressure portable bottles

D. 10 high pressure bail out bottles

E. 14 demand flow regulators
   1. Each regulator has an independent system
   2. 1½-3 bottles per regulator, depending on supply required for station

F. Stations
   1. Pilots regulator (2 G1 bottles)
   2. Co-pilots regulator (2 G1 bottles)
   3. Bow turret regulator (2 G1 bottles)
   4. Bottom turret and tunnel hatch regulators (split usage of 3 G1 bottles)
   5. Navigator and bomb bay regulator (split usage of 3 G1 bottles)
   6. Top turret regulator (2 D-2 bottles)
   7. Two bow regulators (split 3 G1 bottles)
   8. Right waist hatch (3 G1 bottles)
   9. Left waist hatch (3 G1 bottles)
   10. Tail turret (3 G1 bottles)

G. Advantages
   1. Low pressure system
   2. Ten independent systems

H. Refilling system
   1. Filling valve outside on port side aft of bomb bays
      a. refills all bottles except top turret.
   2. Top turret recharged from navigation regulator
   3. When recharging from high pressure system make sure a pressure regulator valve is used

   Keep clear of all oil and grease

I. General Information:
   1. Use oxygen on all night flights from ground up. (Improves vision 50%)
   2. Use oxygen if above 12,000 feet
   3. Use oxygen if above 10,000 feet for two or more hours
   4. Always use portable bottles when walking about aircraft at altitudes above 14,000 feet

   Captain of aircraft should periodically check crew stations at high altitudes

II PRESSURE REGULATOR

A. Visual indicators

1. Pressure gauge (pressure in system)
2. Amber light (lights when pressure is reduced to 100 PSI)
3. Flow indicator
    a. Fluctuates when oxygen is being breathed.
    b. Ball rises and stays stationary, depending on amount of oxygen escaping

B. Auto Mix control lever

1. **"ON"** position
    a. Mixture of atmospheric air and oxygen
    b. Regulates percent of outside air and oxygen as required up to 28,000 feet when outside air is completely shut off, and only pure oxygen enters system (best economy setting)
2. **"OFF"** position
    a. Delivers 100% oxygen to use at all altitudes.
    b. Only used for rapid ascent to high altitude

1. Pressure gauge (pressure in system)

HEATER SYSTEM

I GENERAL EQUIPMENT:

A. Six Stewart Warner Spot Heaters.
   1. Location:
      (a) Two in bombardier's compartment.
      (b) Two forward Instrument Panel for Pilots.
      (c) One on floor of Flight deck by Navigator's table.
      (d) One on 4.1 bulkhead for top turret.

B. Defrost tubes.
   1. Location:
      (a) On all heaters except navigator's.

C. Flame Arrester.
   1. Location:
      (a) One on each heater.
   2. Prevents fire returning to fuel line.

D. Burner Tubes.
   1. Location:
      (a) One in each heater.
   2. Diffuses fuel into combustion chamber.

E. Igniter plug.
   1. Location:
      (a) One in each heater.
   2. Functions as electrical igniter.

F. Cylindrical aluminum oven and exhaust lines.
   1. Exhaust line discharges into low pressure side of engine impeller.

II FUEL SUPPLY:

A. Engine Number 2.
   1. Supplies pilot, co-pilot and top turret heaters.

B. Engine Number 3.
   1. Supplies bombardier's and navigator's heaters.

C. Fuel take-off line.
   1. Location:
      (a) Between cylinders 1 and 14 on high pressure side of engine internal impeller.
   2. Insulated dural tubes.

D. Fuel flow valve.
   1. Solenoid valve located in nacelle.
   2. Operated by heater switch.

E. Manual shut-off valve.
  1. Location:
    (a) Station 4.1 on each side of bulkhead.

F. Three-way header.
  1. Location:
    (a) 4.1, one on each side.
  2. Supply line leads off to individual heaters.

G. Heater safety valves.
  1. Location:
    (a) One in each heater line.
  2. Designed to shut off fuel supply to any heater.

III OPERATION:

A. Master heater switch—**Turn On.**

B. Heater switch for each system—**Turn On.**
  1. Pilot heater switch: For pilot, co-pilot, and top turret heater.
  2. Bombardier's heater switch: For bombardier and navigators.

C. Engine manifold pressure.
  1. Between 25" and 35" H.G. Best manifold pressure 28" H.G.

IV TROUBLES AND CORRECTIONS:

A. Igniter plugs out.
  1. Replace plug.

B. Master solenoid valve inoperative.
  1. Pre-flight inspection necessary.

C. Heaters overheating.
  1. Check motor and fan for operation.
  2. Damper may restrict blower air.

D. Heater smokes after turning off.
  1. Turn switch back to on; reduce manifold pressure on that engine until smoking stops; turn switch to "OFF."

E. Caution:
  1. Have heaters off during take-off and landing.

DE-ICER AND GYRO EQUIPMENT

I GENERAL SYSTEM:

A. Two vacuum pumps.

1. Location: No. 1 engine and No. 2 engine.

B. Distributor valve and electric motor.

1. Location: Starboard side, near ceiling, between station 4.1 and front spar.

C. Vacuum control valve.

1. Location: On flight deck by fuel sight gauges.

D. Air Filter.

1. Location: Forward of instrument panel. Accessible from nose.

E. De-icer boots and lines.

1. Location: Leading edge wing panels and tail section.

F. Gyro instruments.

1. Turn and bank, artificial horizontal directional gyro.

II DE-ICER TROUBLES AND CORRECTIONS:

A. Control valve will not operate.

1. Reason: Mechanical linkage broken or slipping.
2. Correction: Turn valve to **ON** position.

B. Distributor valve will not rotate—one set of bladders inflate and fail to deflate.

1. Cause:

(a) Fuse blown.

1. Replace fuse (Station 4.0 fuse box).

(b) Bad brushes.

1. Replace brushes, or stretch spring that holds brushes in contact with commutator.

(c) A.N. plug loose.

1. Tighten plug.

(d) Wires broken.

1. Repair wires.

(e) Gears out of adjustment.

1. Tighten gear adjustment screws on fore and aft face of distributor valve.

(f) One engine out—No. 1 or No. 2 engine.

1. Switch vacuum to other engine.

III GYRO INSTRUMENT TROUBLES AND CORRECTIONS:

A. Malfunction of gyros—slow erection.

1. Clean air filter.

In lieu of "U" hoses as a means of routing gasoline to the desired location, two selector valves have been mounted on the control panel at Station 5.1 on the left-hand side of the wing center section. This revision obsoletes portions of the "New Fuel System Instructions" contained in Vol. 1, No. 1 Field Service Bulletin of December 15, 1942. The later system operates as follows:

A. To Transfer Fuel From Auxiliary Wing Tanks to Main Tanks.

1. Set auxiliary wing tank selector valve to tank to be drained.
2. On auxiliary fuel transfer panel set main wing tank transfer selector valve to tank to be filled.
3. Turn "ON" auxiliary fuel pump.
4. When main tank is within 50 gallons of being filled, turn "OFF" auxiliary fuel pump.
5. When transferring operation is completed, turn "OFF" both auxiliary wing tank and main tank selector valves.
6. Do not change position of selector valves while fuel pump is "ON."

B. To Transfer Fuel From One Main Wing Tank Cell To Another.

1. Set the fuel selector valve associated with the main tank cells to be drained, and the selector valve associated with the main tank cells to be filled, to the "No.--Tank to No.--Engine and Crossfeed" position.
2. Set the fuel selector valves of the remaining main tanks to the "No.--Tank to No.--Engine" position.
3. Turn "ON" booster pump of tank to be drained.
4. Turn "OFF" booster pump of tank to be filled.
5. Fuel from the main tank to be drained will then be pumped out by its booster pump through its selector valve into the crossfeed manifold. From here it will flow into the tank to be filled through the other selector valve connected to the crossfeed manifold.
6. Fuel under pressure will continue to be fed to both engines from the supply that is being transferred from one group of main cells to another.
7. When the fuel sight gauge on the forward side of bulkhead at Station 4.1 indicates that the tank being filled is within 50 gallons of Full, rest the full tank selector valve to "No.--Tank to No.--Engine" position. The full tank booster pump may then be turned on if normal operation (altitude, etc.) requires its use.
8. If still more fuel should be transferred from the tank to be drained, the crossfeed operation described above should be followed to fill either of the two remaining tanks.
9. After tank has been emptied, set selector valve of empty tank to "Crossfeed to No.--Engine" position. Then set selector valve of the

three remaining tanks to "No.--Tank to No.--Engine and Crossfeed" position.

10. DO NOT attempt to fill more than one main tank at a time. To do so will cause engines to stop since they are connected to the crossfeed manifold and when the tank being drained becomes empty, air is introduced into the crossfeed manifold.

Note—Under the new fuel transfer system, it will no longer be possible to transfer fuel from one main wing tank to another main wing tank via the transfer system. This must be accomplished through the "Cross feed." The The new set-up only provides for a method of transfer from the auxiliary wing cells to the main wing cells.

C. **To Transfer Fuel From The Bomb Bay To The Main Wing Tanks.**

1. Set the bomb bay selector valve, on the catwalk at Station 5, to the bomb bay tank to be drained.

2. Set the selector valve for the one wing tank to be filled to "No.--Tank to No.--Engine and Crossfeed."

3. Set the selector valves for the other three tanks to "No.--Tank to No.--Engine."

4. Set the bomb bay shut-off valve to "Bomb Bay to Crossfeed."

5. Turn ON bomb bay booster pump.

6. Turn OFF the booster pump of the wing tank to be filled. Now the fuel will flow from the selected bomb bay tank through its selector valve, booster pump, and shut-off valve and up into the cross feed manifold. It will then flow out of the crossfeed manifold through the main wing tank noted in Item 2 above. From there, part of the fuel will flow to the engine and the remainder will be forced back through the fuel hose and booster pump (previously turned off) and up into the main tank. When the fuel sight gauges on the forward side of bulkhead 4.1 indicate that this particular wing tank is within 50 gallons of full, turn booster pump OFF and reset selector valves (bomb bay selector and bomb bay shut-off valves) to OFF, and wing tank selector valve to "No.--Tank to No.--Engine."

7. This procedure should be followed until the wing tanks are all filled, as noted above, or the bomb bay tanks are empty.

8. Do not attempt to fill more than one main tank at one time as all engines connected to the crossfeed manifold will stop running when the bomb bay tanks are completely empty and air is introduced into the crossfeed manifold. When an engine stops set its main selector valve to "No.--Tank to No.--Engine," and start the engine.

AUTOMATIC PILOT TYPE C-1
(MINNEAPOLIS-HONEYWELL REGULATOR COMPANY)

1. GENERAL:

1. **Purpose:**

The C-1 series (24 volt) automatic pilot was developed by the Minneapolis-Honeywell Regulator Company for use with the Norden bombsight. This automatic pilot will not only relieve pilot fatigue, but it can also execute all the operations that a human pilot can, by manually controlling the airplane at the desired altitude. This equipment can be used:

(a) As a fire control apparatus to direct the airplane through the controls of the Norden M. Series bombsight.

(b) As a navigational pilot, which will hold the airplane on a precision course and with which either the pilot, navigator, or bombardier can direct the airplane.

(c) When used in conjunction with the M-Series bombsight, the automatic pilot permits the use of the bombsight as an accurate driftmeter, by tracking some object on the ground with the fore and aft cross hair of the sight.

2. **Accuracy.**

The C-1 pilot can:

(a) Follow bombing-run corrections more accurately than a pilot.

(b) For navigational purposes, hold a true course better than a human pilot.

(c) For bombing purposes, level the ship more accurately than is possible for a human pilot. At high altitudes in heavy bombardment type airplanes this factor is appreciable and important. Picked bombardier pilot teams from the AAFFTC were able to demonstrate and convince all personnel whom they contacted that the C-1 pilot was very effective; in fact, greatly superior to the pilot following the PDI method of bombing. Most pilots were extremely enthusiastic with the results obtained. Bombing accuracy with the C-1 pilot showed a decrease in circular error of more than 75 feet in an overall average, when compared with the average errors of the same experienced bombing teams employing manual (PDI) control of the airplane.

3. **Evasive Action:**

During the approach on a bombing run the C-1 pilot can be used to great advantage by the bombardier. Because of the poor pilot visibility at high altitudes, it is a great advantage to give the bombardier control of the ship on C-1 pilot in order to secure that good anti-aircraft fire evasive action until the airplane arrives at a point twenty seconds from the bomb release line at which point the final approach is made with present data. This technique will give the shortest possible straight and level approach, which in turn gives the maximum safety to equipment and personnel and maximum bombing accuracy.

2. **Flight Operation of the C-1 Automatic Pilot:**

(See card in plane for condensed procedure).

1. Before Take-Off.
   - (a) Check to see that ground check was completed.
   - (b) Engage AUTO PILOT CLUTCH of stablizer.
   - (c) Disengage BOMBSIGHT CLUTCH of stabilizer.
   - (d) Adjust all KNOBS on PILOT CONTROL BOX to "pointers up" position. If previously adjusted in flight, do not alter settings unless necessary.
   - (e) Set TURN CONTROL at center (detent) position.
   - (f) Check to see that MASTER SWITCH of C-1 is off.

2. After Take-Off:
   - (a) After airplane has reached an altitude of at least 1000 feet, throw on MASTER and STABILIZER switches (connected by bar).
   - (b) Turn on TELL-TALE LIGHTS switch.
   - (c) Trim airplane to fly straight and level, for "hands off" flight. On bombing missions trim ship to fly at desired airspeed with bomb bay doors opened.
     - (1) With plane level, bombardier should level stabilizer.
   - (d) Turn on PDI and SERVO switches after MASTER switch has been on for about ten minutes.
   - (e) PDI should be centered by bombardier by moving **disengaged** Auto Pilot clutch right or left until pointer is at zero. Then engage Auto Pilot clutch and hold down directional arm lock to keep PDI on zero during steps 3 (a), (b) and below:
     - (1) An alternate method of centering PDI is for the pilot to turn the airplane until PDI is at zero. This procedure will only be possible if Auto Pilot clutch is engaged as in 2 1 (b) above. If this method must be used, reverse order of 1, (a) and (b) below.
   - (f) After MASTER switch has been on 12 or 15 minutes, the control axis may be engaged.

3. **To Engage Control Axis:**

(a) With wings level adjust AILERON CENTERING knob until both aileron tell-tale lights are out. Throw on AILERON switch.

(b) With PDI on zero, adjust RUDDER CENTERING knob until both rudder tell-tale lights are out. Throw on RUDDER switch.

(c) With airplane flying level, adjust ELEVATOR CENTERING knob until both elevator tell-tale lights are out. Throw on ELEVATOR switch.

(1) Bombardier now releases directional arm lock. (Note: Auto Pilot clutch must be engaged.)

(d) Airplane is now under control of the automatic pilot.

(1) Check artificial horizon to see if wings are level. If not level, readjust AILERON CENTERING knob until wings level.

(2) Check PDI to see if on zero. If not on zero, readjust RUDDER CENTERING knob until PDI is on zero. If oscillating slightly both sides of zero, adjustment not necessary. If adjustment causes ball to ride out of center of inclinometer it is necessary to disengage and check trim of plane.

(3) Check sensitive altimeter on airspeed indicator to see if plane is gaining or losing altitude. If so, readjust ELEVATOR CENTERING knob until plane is flying at constant altitude.

(4) Do not adjust trim tabs after engaging Auto Pilot.

4. **To Set Sensitivity Controls:**

(a) Advance SENSITIVITY knob toward maximum on each axis. If chattering of control column, wheel or pedals develops reduce SENSITIVITY until chattering stops.

5. **To Set Ratio Controls:**

(a) Advance RATIO knob on each axis towards maximum. Since RATIO may affect CENTERING, RATIO should be changed **slowly**. Readjust CENTERING, if necessary, after making RATIO changes.

(b) If the airplane develops a tendency to fishtail or to oscillate about its roll or pitch axis, reduce RATIO slowly until it stops.

(c) If no tendency to oscillate is observed increase RATIO to maximum.

6. **To Set Turn Compensation Controls:**

(a) Aileron and Rudder TURN COMPENSATION knobs are used only to coordinate turns made from bombsight or stablizer.

(b) Have secondary clutch arm on the stablizer disengaged and moved slowly to either stop. The arm should be held in this position until the TURN COMPENSATION controls are set.

(c) AILERON COMPENSATION knob on P.C.B. should be turned until the Gyro horizon shows a bank of 18 degrees.

(d) RUDDER COMPENSATION knobs should be turned until the ball is in the center of the inclinometer.

(e) ELEVATOR COMPENSATION knob should be turned until the sensitive altimeter shows no loss or gain in altitude.

(f) Have secondary clutch arm reengaged and note manner in which airplane returns to level flight. See if PDI returns to zero. If PDI does not return to zero, change AILERON and RUDDER RATIO adjustment.

7. **To Adjust Turn Control Turns:**

(a) Remove the two black protecting caps on the side of TURN CONTROL exposing the trimmer screws. Replace caps after completing adjustment. NOTE: On console model P.C.B (Pilot's Control Box) the TURN CONTROL is located in upper left-hand corner. AILERON TRIMMER, marked "A" and RUDDER TRIMMER, marked "R" are located on P.C.B. below SENSITIVITY knobs.

(b) With PDI centered, rotate TURN CONTROL knob slowly and evenly to an indicated turn of 30 degrees in either direction (beginning of multiple yellow lines on Console P.C.B.).

(c) Turn AILERON TRIMMER screw (unlabeled) until the Gyro horizon shows a bank of 30 degrees.

(d) Turn RUDDER TRIMMER screw labeled "RUD" until the ball is in center of the inclinometer.

(e) Elevator Compensation knob should be adjusted until the plane holds constant altitude in turns as in **6** (e) above.

(f) To bring airplane out of the turn, slowly rotate TURN CONTROL knob to zero position, **wait until wings are** level, and then click the knob into center (detent) position. **Do not forget to return T.C. to center.**

(g) Try a turn in opposite direction and see if turn is coordinated. In rough air, do not use TURN CONTROL for bank of more than 30 degrees. When turning in climb or glide, restrict bank to 5 degrees less than maximum for level flight.

(h) Do not adjust centering knobs while in a turn.

8. **To Adjust Dash Pot:**

(a) Tendency for the airplane to fishtail or oscillate can often be remedied by adjusting the DASH POT on directional pane. Unlock by moving lever counter-clockwise. Turn knurled nut up or down until hunting ceases; then lock adjustments.

3. OPERATION DURING BOMBING APPROACHES:

1. Place airplane under Automatic Pilot control, as outlined above, with bomb bay doors open, at approximate altitude and airspeed designated for the bombing mission.

2. Turn airplane toward target.

3. When the pilot tells the bombardier "on course," the bombardier should first engage the directional clutch, then disengage the secondary clutch and all corrections will then be made by the course knobs on the sight.

4. Proceed on bombing approach as usual, observing the following additional precautions:

(a) Turn the course knobs smoothly, not in jerks.

(b) During the run, the pilot will not tamper with any of the knobs on the P.C.B. except the elevator centering knob which he will operate in conjunction with the throttles to keep the altitude and airspeed at their prescribed values.

5. Upon completion of the bombing approach and when the bombardier has dropped the bomb, he will engage the secondary clutch and disengage the directional clutch and return control of the airplane to the pilot.

4. DO'S AND DON'TS:

Do insure that the C-1 pilot reaches operating temperature for which it was calibrated before adjustment.

DON'T wear down airplane batteries if necessary to warm up equipment on the ground. Use auxiliary power source.

DON'T turn on master and stabilizer switches until at least 1000 feet altitude has been reached.

DO center stabilizer brush before adjusting the C-1 pilot.

DON'T turn airplane manually when on the C-1 pilot.

DON'T tamper with equipment you don't thoroughly understand.

DON'T fail to check ability to overpower before flight.

5. COMPLETION OF MISSION:

Check the following before leaving the airplane:

1. Check that all switches are off.
2. Check that the ship's master switches are off.
3. Check that the control surfaces are locked.

6. EMERGENCY MAINTENANCE:

Maintenance of the series B-1 and C-1 Automatic pilot consists of a series of periodic inspection and such replacements, repairs, adjustments, cleaning and lubrication as may be necessary from time to time to insure satisfactory operation of the equipment. Detailed inspections are made at specified intervals, and the frequency and performance of these are carefully outlined in the D.C. No. 11-60-1. Qualified maintenance personnel should perform maintenance on the equipment. There are, however, some common troubles which the bombbardier can remedy. The principal sources of trouble are:

1. Grease and dirt in potentiometers will prevent the wiper arms from making contact with the potentiometers. Potentiometers should be cleaned with a clean lintless white cloth (or soft brush) and white gas or benzol.

2. Contact points on limit switches of the servos, and the contact points on the roller cut-out switch may become dirty and greasy, thus preventing contact. These contact points may be cleaned with crocus cloth, orange wood, or a point file. If crocus cloth is used, wash points with white gas or benzol. Do not attempt while auto pilot switch is on.

3. Excessive oiling of the equipment can be responsible for many kinds of trouble. In addition to causing dirty potentiometers, the excessive oil in the servo units is likely to get on the cork surface and the metal facing, permitting slipping of the clutch and brake so as to make servos inoperative. Cork surfaces may be cleaned with alcohol. However, if they are saturated with oil they must be replaced.

4. Brushes and commutators on servo motors may become dirty or greasy. Wipe off dirt. Start motor, then turn it off. Touch soft rag to commutator to remove dirt. Do not use abrasive material or brush on commutator.

5. Dash pot may need refilling. Refill to three-fourths level with hydraulic fluid (Spec. 3580-C). Never use prestone, kerosene or other liquids which cause rust.

6. Check electrical connections, see that there are no exposed wires and that there are no loose connections.

ALTITUDE- 8000 FT. PRESS. ALTITUDE
ALTIMETER - SET 29.92
OUTSIDE AIR TEMP. 15° C.

MAXIMUM RANGE PB4Y-1 (FERRY CONDITION)

3100 GALS. OF GAS-GROSS WEIGHT 62000 LBS. ESTIMATED
RADAR WING ANTENNAE REMOVED & STOWED-CONSAIR NOSE TURRET-BALL BELLY TURRET
CREW-6 C.G. ESTIMATE FORWARD-TAB SETTING 3° NOSE HEAVY CRUISING FLIGHT

WEIGHT 62 000 / WT. END OF CLIMB 60920 / CRUISING WEIGHT 58040 / 55440 / 53140 / 50900 / 48860 / 46860 / 44900 / 43970 / 43375

TAKE OFF 50" M.P. 2700 R.P.M.
CLIMB 41" M.P. 2500 R.P.M. INDICATED AIR SPEED 160 M.P.H.

TIME	20 MIN.	1ST 2 HR.	2 ND 2 HR	3RD. 2 HR.	4TH 2 HR.	5TH 2 HR.	6TH 2 HR.	7TH 2 HR.	LAST HR.	38 MIN.	
C.A.S.	160	170	170	165	165	160	160	160	150	150	CALIBRATED AIRSPEED M.P.H.
R.P.M.	TO	2200	2150	2000	1975	1850	1825	1800	1700	1700	
M.P.	CLIMB	32	32	31	31	31	31	31	30	30	
T.A.S.	170	197	197	190	190	183	183	183	171	171	MILES PER HOUR
G.P.H.	AVER. 550	240	216	191	187	170	166	163	155	155	EXPECTED FUEL USED PER. HR.
GAS REMAINING	2920	2440	2008	1626	1252	912	580	254	99	EMPTY TANKS	EXPECTED FUEL REMAINING
DISTANCE STATUTE MILES	57	451	845	1225	1605	1971	2337	2708	2874	3007	EXPECTED RANGE- STATUTE
DISTANCE NAUTICAL MILES	49. 5	392	735	1064	1395	1714	2030	2350	2495	2616	EXPECTED RANGE- NAUTICAL

NOTE: CLIMB TO 500 FT. ABOVE CRUISING ALTITUDE -----LEVEL OFF
SET R.P.M. AND M.P. TO FIRST 2 HR. PERIOD. TRIM SHIP-GO TO AUTO LEAN.
LET PLANE SLOWLY DECEND TO DESIRED ALTITUDE.
CHECK R.P.M. AND M.P.

MAXIMUM RANGE T/D
FLYING TIME 15:58
TOTAL STATUTE MILES 3007
TOTAL NAUTICAL MILES 2616

RECORD TO BE KEPT BY PILOT

ACTUAL FUEL USED											
ACTUAL DISTANCE TRAVELED											

INSTRUCTIONS
LONG RANGE OPERATION

The preceding chart is to be used as a guide to the pilot and navigator in completing a ferry flight to Honolulu in a PB4Y-1, weighing approximately 62,000 pounds, and is based on data accumulated during an actual flight conducted under the conditions given on the chart.

From tests conducted, it is apparent that very little additional range will not be gained by adding additional gasoline to the 3100 gallons unless the weight can be kept under 62,000 pounds. It will be noted on the chart that 2200 r.p.m. and 32″ manifold pressure are used the first two hours of the flight in order to maintain 170 m.p.h. calibrated airspeed. This r.p.m. and manifold pressure constitute 65% of the available horsepower of the engines. Automatic lean mixture setting may be used with this percentage of power. At any power above 65%, Automatic rich will be used. It may be found that at 65% power in Auto lean position that the head temperature will approach the maximum allowable of 230° Centigrade. If the head temperatures do approach the maximum allowable of 230° C., reduce them by minor adjustments of the cowl flaps. The cowl flap opening should be kept as small as possible in order to prevent any loss in airspeed. Do not open over 5°.

The principle of long range operation or most miles per gallon is based on airspeed versus horsepower versus coefficient of lift. The angle of attack of the PB4Y-1 relative to the amount of power being used during the first four or five hours of flight while the plane is in an over-loaded condition is very critical and requires very proficient pilotage to get the most miles per gallon of gas used. It requires very close attention to maintain a constant altitude and airspeed. The A.F.C. should not be used if any oscillation results. The plane should be flown manually within just as close limits as possible and with as little over-control as possible. The following suggestions are offered for the information of pilots who have not flown the PB4Y-1 in an over-loaded condition on a long range operation:

1. **Prior to Take-Off:**

   Be sure that plane is properly loaded. As much as 10 m.p.h. may be lost by cruising in a tail heavy attitude.

2. **Take-Off:**

   Do not pull the plane off the ground. Fly it off normally. It will take a much longer run than when loaded normally, and will not pick up speed as rapidly after leaving the runway. Obstructions at the end of a field will be cleared much easier

if plane is flown off and not pulled off.
Do not raise the flaps until airspeed reaches 145 to 150 m.p.h. Climb straight ahead, if possible, until plane is stabilized at its climbing altitude of 160 m.p.h. indicated.

3. **Cruising:**

Maintain the airspeeds as given on the chart. The manifold pressure and r.p.m. given for the air speeds are approximate and may vary slightly in different planes. It is believed that the chart figures are conservative and that in most cases it will be possible to maintain the airspeed as given with slightly less power, with a consequent reduction in gasoline use. Alter the r.p.m. to obtain the recommended airspeed.

The same airspeeds as given in the chart should be maintained for any altitude flown. The chart is made up for 8000 feet. For altitudes under 8000 feet, the power should be reduced to maintain the same airspeed. The same holds true for higher altitudes also, except it is not recommended that 8000 feet be exceeded the first four hours due to the probability of having to exceed 65% power to maintain the given airspeed.

Maintain an accurate **hourly** record of gasoline consumed and compare with the figures given on the chart. It is impossible to level the gasoline gauge inclinometer without losing altitude, due to the angle of attack while the plane is heavily loaded. Therefore, although the gauges will not accurately indicate the amount of gas in the plane, a fairly accurate record may be kept hourly of the amount used.

Use from 1½ to 2 inches of turbo manifold pressure when cruising. In other words, set manifold pressure for 1½ to 2 inches less than that called for with throttles, and bring manifold pressure up to that required by use of the turbo controls.

Remember that proficient and precise pilotage is absolutely mandatory during the first four hours of flight, and will be reflected in power required to maintain the necessary airspeed which in turn reflects miles traveled and gasoline consumed.

MIXTURE CONTROL

Best power results from a mixture proportion of one pound of fuel to approximately 14 pounds of air (.072 F/A ratio). While the greatest amount of power for a given weight of fuel/air mixture results from this ratio, optimum power per pound of fuel requires a leaner mixture, which will weigh more, but with the added weight being air instead of fuel. When progressively leaning from the .072 F/A ratio (approximately automatic lean in the R-1830 engines) the fuel flow at a given power will decrease until the ratio is 17 to 1 (.059 F/A ratio), and will remain approximately constant from this point to a 19 to 1 ratio (.052 F/A ratio). During this progressive leaning from a .072 F/A ratio, the cylinder head temperatures will rise until past a 15 to 1 ratio (.067 F/A ratio), and will progressively fall as the leaning is carried further. At .059 F/A ratio, the "entering point" of the minimum fuel consumption zone, the temperature will be below that resulting from the automatic lean mixture at all powers up to 70%. This coincidence gives a positive indication of the proper position of the mixture control lever for manual leaning.

The leaning **must** be carried down to a point where the temperature drops to below that of auto lean to obtain optimum fuel consumption with satisfactory engine operating conditions. Further leaning may be desirable for cooling purposes, but fuel consumption will not decrease. The cooling effect is caused by the excess air which must be introduced in the mixture to maintain power as the leaning progresses. It was found that adding 3" to the manifold pressure used with a .072 (automatic lean) F/A ratio will normally give the same power when the mixture is leaned to a .059 F/A ratio. To date, this full lean mixture has not been extensively tested above 70% power, but cooling difficulties will limit use of the mixture in higher powers for continuous operation. In automatic rich mixture, internal cooling is accomplished by an excess of fuel, instead of an excess of air as recommended for the lower powers.

The following procedure is recommended for "setting up" the full manual lean mixture:

(a) **Fly 15 to 20 minutes in automatic lean mixture, using r.p.m. specified** for the weight and airspeed. Note the cylinder head temperatures.

(b) **Increase the manifold pressure on one engine by 3".**

(c) **Immediately lean until the cylinder head temperature begins to drop,** if the tachometer hand starts to oscillate you have over-leaned, and should enrich slightly.

(d) **Lean other engines individually, as above.**

(e) **Watch head temperatures and r.p.m. closely for 20 minutes,** if a head temperature starts to rise, lean further; if it falls too far, enrich slightly. A drop of twenty or more degrees may cause "self leaning," due to cooling of ambient air surrounding carbureter and induction system, and engine may surge or cut. Adjust so that temperatures are not over 232° C. and not less than 5°

C. below that obtained during the stabilization run with automatic lean mixture.

CAUTION: LEANING IS INADEQUATE UNTIL A TEMPERATURE DROP IS OBTAINED. AUTOMATIC LEAN MANIFOLD PRESSURE LIMITS SHOULD ONLY BE EXCEEDED IN CONNECTION WITH A LOWERED HEAD TEMPERATURE.

DO'S AND DON'TS

1. Mark the position at which you have leaned each engine satisfactorily on the mixture control quadrant; this will give you the approximate lever position for future leaning. Adjustment therefrom will involve a very small movement of the lever, and with experience this final adjustment will be easily made by watching the head temperature and r.p.m.

2. Don't allow head temperatures to rise during the leaning procedure. Move the mixture control lever through the "hot zone" with a steady pull, watching the head temperature. When you think you have gone far enough, stop a moment; if the head temperature rises or doesn't drop, lean more. No damage will result if you do not lean too far. The first indication will be oscillation of the tachometer hand, and if not corrected, the engine will spit back or cut. It will immediately resume firing if enriched. With experience, there is no excuse for leaning until the engine cuts, and no need of leaning until it surges except when the cylinder head temperature gauge fails. In case of temperature gauge failure, lean until oscillation starts, then enrich slightly. If, after 20 or 30 seconds, oscillation continues, enrich a little more. (Never more than ½ notch at a time.)

3. Watch the engine instruments closely for some time (at least half an hour) after leaning, and stabilize all engines so that the head temperatures are equal (with due allowance for faulty indication). An excessive temperature drop will cause self leaning, and the engine may be expected to surge (and cut, if the surge is not corrected) 15 or 20 minutes after the controls are set. Enrich slightly to prevent this.

4. Don't overlean; a drop of 5 to 10° C. in head temperature is sufficient, unless a larger drop is required to cool an engine which has been running definitely hot. The recommended increase of 3" in manifold pressure is only sufficient to maintain power with an F/A ratio of .058, further leaning will require more manifold pressure if power is to be maintained.

5. **Stand** by for mixture adjustment under any of the following **conditions:**

(a) **Outside air temperature change of over 10° C.** If colder enrich mixture; if warmer, lean the mixture. To maintain power it will be necessary to reduce manifold pressure or r.p.m. when enriching for cold, and to increase either manifold pressure or r.p.m. when leaning for warmth.

(b) **Cooling of engine during prolonged descents.** Will require temporary enrichment, and it is recommended that in such case the mixture be put in automatic lean after the descent and before cruising power is resumed, and that it be kept there until the heads have increased to normal temperature. (ALWAYS REDUCE MANIFOLD PRESSURE TO AUTOMATIC LEAN LIMITS BEFORE MOVING MIXTURE CONTROL TO AUTO LEAN POSITION.)

(c) **Change of power.** Additional leaning is required as power is increased, but to a very slight extent up to 700 h.p. per engine (neutral blower). Normally if the mixture is leaned to a mixture ration of .057, no mixture adjustment need be made for any power change below 700 h.p. (A cylinder head temperature 10° C. below that resulting from automatic lean operation approximates this ratio.) When using a power above 700 h.p. in neutral blower (665, low blower, 635 in high) it will be found that additional leaning will usually be required. Remember that the cylinder temperature relationship between automatic lean and full manual lean is in respect to a given power. Therefore, if the automatic lean temperature at 600 horsepower is 200°, while at 750 horsepower it is 215° the leaning relationship would be a drop from each of the respective temperatures. Therefore, in changing from power to power, you cannot use the indicated temperatures as a guide. Instead, check by either enriching or leaning slightly. If the temperature goes up when you enrich and down when you lean your adjustment is correct. If the reverse occurs, lean further.

(d) **Frequency of adjustment.** Don't keep fiddling with the mixture control. Once the initial setting is made, give the engine time to stabilize; then you will have an indication of what, if any, adjustment is required. If the power is changed, watch the cylinder head temperatures and the r.p.m until the engine is stabilized at the new power before readjusting the mixture control. There is one exception to the above; NEVER ALLOW THE TEMPERATURES TO RISE ABOVE 232° C. When they have stabilized at any temperature above 210° C. try to bring them to or below that temperature by leaning. Meanwhile increase manifold pressure sufficiently to maintain power.

6. Never change cowl flap position during a mixture adjustment, otherwise your relative temperature comparison will be nullified. Keep cowl flaps closed except when at or near the temperature limits. (232° continuous, 260° temporary.)

7. If engine fails to lean normally it is an indication of subnormal engine condition. During tests, such failure was invariably found to be the forerunner of engine trouble, and in two cases where operation was continued in auto rich, despite unsatisfactory leaning results, one bank of ignition failed within a few hours from the time that the unsatisfactory condition was first noted. The slow burning full lean mixture will not ignite with sub-standard ignition, it will not ignite when diluted by piston ring and valve blow-by, and it will not ignite when the fuel is below the specified octane rating. Most probable causes and typical indications are:

(a) Faulty ignition (engine surges before a temperature drop can be obtained). Check harness, plugs, timing, and magneto, in order named. Reduce manifold pressure to auto lean limits.

(b) Burnt or sticky valves or rings. (Engine can be leaned, but becomes rough with a mixture at which smooth operation should be obtained.) Check compression.

(c) Less than 100 octane fuel. (Cannot lean sufficiently to obtain a temperature drop, engine is apt to cut out without the normal surging which precedes cutting, as the engine is progressively leaned.) Check octane rating of fuel, or try leaning with a fuel of known octane rating.

8. Automatic propeller control is recommended when leaning, as the action of the propeller pitch governor accentuates engine surge, so that an actual surge of 10 r.p.m. with fixed pitch propeller may be amplified to 50 r.p.m. in automatic by the limiting action of the governor. (Tests were also run in fixed pitch, on the theory that power would be constant if, after the 3″ manifold pressure had been added, the mixture was leaned until the original r.p.m. was obtained. Checking the method on the torque motor showed that a minor change in plane attitude or speed caused an appreciable change in the power required to

maintain r.p.m.; therefore, the method was discarded as unreliable.)

NOTE: Above method is for manual mixture control of R-1830 Engine.

To be done in emergency **ONLY.**

And then at low power **ONLY.**

RADIO EQUIPMENT

COMMAND RECEIVERS AND TRANSMITTERS

The command set consists of three independent receivers and two transmitters. The three receivers cover a frequency range of 190 to 550, 3000 to 6000 and 6000 to 9100 kc. The three receivers feed through the filter box and into the pilot's junction box when the switch on the pilot's junction box is turned to the "Command" position.

To tune any or all receivers, turn the receivers main switch from the "off" position to the "MCW" position and turn the "A tel--B tel" (B "tel" not wired in T.L.U. planes) switch to "A" side. This will feed receiver into all of the plane's interphone control boxes. The "B" side of the switch is to be used with phones plugged into the "B" tel phone plug on back of receiver control panel, this may be used when it is desired that the pilots each listen to a different frequency. Turn hand crank until the frequency dial is on desired frequency.

The command set has 2 transmitters, the first covering the 3000--5000 kc. frequency band, the second the 7000--9100 kc. frequency band. The transmitters are set to any desired frequency and a proper notation is made on the space provided on transmitter control box. T.L.U. planes are set so that No. 1 transmitter is on 3105 kc. and No. 2 transmitter is on 7535 kc. The No. 3 and 4 position on transmitter control box do not have any transmitters attached to them, but in case of interphone failure, positions 3 and 4 may be used for interphone communication. To turn on the transmitter put "on--off" switch to "on" position, turn "Tone--CW--Voice" switch to voice position, and the four position switch to the No. 1 or 2 position, depending on frequency desired.

The command set is a low power set to be used for inter-squadron communication or for plane to ground communication where distances are small as communication with airport control towers. The command set may be used to receive radio range signals, but it is not recommended as the antenna is such that a very poor cone of silence and a very narrow range leg are obtained.

The command transmitter control box has a couple of added features, a microphone jack, for plugging in on command set only, and a jack for plugging in a separate key.

COMPASS RECEIVER

This receiver covers a frequency range from 200 to 1750 kc., this includes the radio range frequency band and the commercial broadcasting band.

The receiver has two control boxes, one in the cockpit, and one in the navigator's compartment. Control of the receiver may be had by either control box, by pushing in the control transfer switch. The green light will indicate the box having control of the receiver.

To place receiver in operation turn pilot's junction box switch to "compass" and push in the control transfer switch if the green light is not on. Turn power and antenna switch from "Off" position to "Antenna" position, and select frequency band desired by turning band change switch to the proper frequency band; tune in station with hand crank.

There are two other positions on power and antenna switch "Loop" and "Compass."

In the loop position the receiver is connected to the shielded loop only. The position of the loop is indicated by the radio compass indicator. The needle points in the same direction as the hole in the loop. The loop may be rotated in either direction, by use of the loop "L or R" switch, by turning switch to "L" position loop will rotate to the left; in the "R" position to the right. The speed of rotation may be controlled by pushing in on the switch for a faster rotation.

The loop has the bi-lateral feature, that is, it will give two nuls 180 degrees apart so that a line of bearing only can be obtained.

When using the loop on a broadcasting station it is usually better to turn the "Voice—CW" switch to "CW" position and tune the receiver to get the carrier wave squeal. In this position it is easier to obtain a sharp, well defined null.

To use the compass receiver in the compass position, tune in station as before on "Antenna" and then shift to "Compass." Retune receiver to a maximum, using ammeter on control box. In this position the radio compass needle will point to the station giving the continuous relative bearing of station from plane.

On some types of stations it is very difficult to obtain a good bearing. The older type range stations (loop antenna type) and most higher frequency radio stations, especially at sunset or sunrise, as the needle will oscillate quite a bit. Some times thunder storms in vicinity will cause needle to oscillate or even to point at storm, rather than station.

The loop in the 90 degree position may be used in heavy rain, snow, or dust static, when all other receivers are blocked.

For radio range operation it is suggested that the antenna position of receiver be used as in this position the whip antenna gives a very good cone of silence. If the "Compass" position is used, be sure and remember that it has an automatic volume control and no fade or build up will be encountered.

FILTER BOX

Each pilot's junction box is connected to a filter box. The filter box has a threet way switch "Voice, Range and Both." The switch should be left in the "Both" position for normal operation of either range station or voice reception. The "Voice" position should be used to filter out the range station signal when voice communication with the range station is desirable. It may be some help in filtering out some static, under heavy static conditions. The "Range" position should be used to filter out any voice that is modulated into a range signal, if it is interfering with the range signals. It will also sometime eliminate some static under severe static conditions.

LIAISON RADIO EQUIPMENT

The liaison receiver and transmitter are the plane's main radio set. It consists of one receiver covering a frequency band of 1500 kc. to 18000 kcs., and a transmitter having seven removable units, the first of which covers 200 to 500 kc., and the other six together cover the frequency range from 1500 to 12000 kc.

It should be remembered that the liaison set is a very powerful set, and can be used from the cockpit by either pilot by switching to "liaison" position on pilot's control box. The proper frequencies must be first set up by the radioman. The pilot has a limited control of received volume through his control box rheostat.

MARKER BEACON RECEIVER

The Marker Beacon equipment consists of a 75 MC receiver connected to an indicator lamp on the pilot's instrument panel. The Marker Beacon receiver will give a visual signal when the plane passes over a fan marker, or Z marker in cone of silence of a radio range station.

The power for the equipment is taken from the radio compass receiver, therefore, it is necessary that the radio compass be turned on for the marker beacon receiver to operate.

INSTRUMENT FLYING

INSTRUMENT CHECK PRIOR TO FLIGHT

1. **Flight Indicator:**
   - (a) Uncage after engines are started.
   - (b) Horizon bar should move slowly downward and remain absolutely level.
   - (c) Adjust little airplane.
   - (d) Allow engines to run five minutes to attain proper speed, then check the horizon bar for any tendency to tip over while making turns on ground.
2. **Directional Gyro:**
   - (a) Uncage gyro after engine has started.
   - (b) Rotor speed is attained in five minutes.
   - (c) Uncage with a sharp twist of the caging knob. It should remain steady.
   - (d) Set with magnetic compass and recheck with compass when in take-off position.
3. **Turn and Bank Indicator:** While taxiing aircraft, check indicator while making left and right turns. Needle should be positive in its indication and not sluggish. See that ball is free in the ball race.
4. **Suction Gauge:** Proper suction of 4.0″ Hg to 4.5″ Hg.
5. **Altimeter:**
   - (a) Set to the station altimeter setting. It should then read the elevation of the field. If it doesn't, note the scale error. Tap face of instrument and set if necessary.

INSTRUMENT TAKE-OFF

After the ship has been readied for take-off, the hood should be snapped on, leaving ample forward visibility for the check pilot, and the ship lined up as straight as possible with the runway being used. The D/G should be set at the nearest five degrees to the heading of the runway. It is important to have it set to an even figure such as 240, as this heading has to be held very exact during the take-off run. The three instruments used in this take-off are the D/G, A/H, and A/S. The sequence of steps in this operation are as follows:

1. Hold the brakes and apply power to about 25″. Release brakes and continue application of power to about 40″, then release throttles to co-pilot and keep attention focused on the Gyro, holding exact gyro heading.

2. When the airspeed reaches 75 to 80 m.p.h., start the wheel back until the nose-wheel leaves the ground, checking the attitude of the small airplane on the A/H.

3. The airplane should be held in this attitude until the A/S reaches 115 to 120 m.p.h., and the airplane leaves the ground.

4. At this time the attitude of the A/H should be noted, and the small indicator airplane raised slightly, and the ship held in this position. Special emphasis should be noted of the fact that during this take-off, the rate-of-climb indicator and altimeter are completely disregarded, as these instruments will give an erroneous reading during initial take-off run.

5. After the plane is airborne, hold the ship in this attitude until approximately 200 feet is reached, then check the A/S against the flight indicator for the proper climbing attitude and continue climb, continually checking flight indicator, A/S and D/G.

MANUAL LOOP ORIENTATION

1. Tune in radio station on antenna position of the radio compass.

2. Turn control switch to loop position and adjust null width to about 10 degrees by use of volume control.

3. Set needle on radio compass dial to the ninety degree position.

4. Turn plane until the null is obtained, noting gyro heading of middle of null. (This places station abeam etiher to port or starboard.)

5. Hold above heading until the null has progressed ten degrees or more in either direction from ninety degrees. Check position of null by turning loop manually. If the null has progressed forward, the station is to the left. If the null has progressed aft the station is to the right. **THE TIME REQUIRED TO GET A TWENTY DEGREE NULL CHANGE MULTIPLIED BY THREE GIVES THE APPROXIMATE TIME THE PLANE IS AWAY FROM THE STATION.**

6. Put the compass needle on the zero position and turn toward the station until the null is obtained. In this position the station is ahead.

7. Home on the station, checking the width of the null occasionally, keeping it about ten degrees wide. Homing on a station may be done best by flying a heading and watching the position of the null by keeping the needle on the null with the manual turning dial, adjusting the heading as required.

8. When over the station it is impossible to obtain a null. Key clicks can be heard if a range station is being used. When using this method remember it is very easy to pass over station and not know it except for a slow increase in null width on leaving station. After determining heading to station and three or four minutes before arrival as determined from paragraph five, turn forty-five degrees to one side or the other, and fly for one minute, and then resume base course again. This will cause plane to pass to one side of station. When

null has progressed to the 270 or 90 degree position the station is a-beam.

9. When using the loop on a broadcast station a better null may be obtained by turning the Voice--CW switch to a CW position, and re-turning for a carrier wave squeal.

10. It should be remembered that the loop is shielded, and that it can be used sometimes when all other radio is drowned out by either rain, snow, or dust static. When using it this way turn loop to the 90 or 270 degree position.

USE OF "COMPASS" POSITION

1. Tune in desired station, adjust to maximum input with am-meter and set switch to "compass" position.

2. In this position a continuous uni-lateral relative bearing from plane to station is obtained. The radio in this position may be used to leave or approach any station on any given heading.

3. It is desired to home in on a station on instruments at 8000 feet, and then to make a low approach to the station on a heading of 270 degrees. This problem or any other problem could be done as follows:

- (a) Tune in station on compass.
- (b) Turn plane until compass needle is at zero position.
- (c) Fly plane to station by keeping needle on zero position. (In case of cross wind the plane's track to station will be such that the plane will tend to make an up wind ap-proach to station.) This will lengthen approach to station by a few minutes but is such a small amount that it can be disregarded.

4. On reaching station turn to a heading of 90 degrees and fly for about one minute or until needle has indicated that station is aft of plane.

5. Needle will now be in a position such that it indicates the station is aft and north or south of plane, depending on the original ap-proach heading to station. If plane is south of desired track (90 degrees from station) the radio compass needle will point to a relative bearing greater than 180 degrees. If plane is north of track the needle will indicate a bearing of less than 180 degrees.

6. If the needle indicated a relative bearing of 200 degrees, then the plane is south of track. To return to track take some heading that will take plane to the desired track. A heading of 45 degrees will get plane back on track.

7. Turn to heading of 45 degrees and fly this heading until radio compass needle indicates plane is back on track. Plane will be on

track when needle comes to 225 degrees. At this point return to the 90 degree heading and radio compass needle will turn to 180 degrees indicating that plane is on a 90 degree track from station.

8. Fly this heading until at a point four or five minutes from station.

9. Make a 45 degree right turn and fly for one minute.

10. Make a 180 degree turn to left. This will put plane on heading of 315 degress.

11. Hold this heading until compass needle indicates bearing of 315 degrees.

12. Turn to a heading of 270 and compass needle will indicate relative bearing of zero.

13. Fly heading of 270 degrees until station is reached, or until the radio compass needle indicates that a wind has drifted plane off its course. This will be indicated by needle progressing to the right or left. If progression is to the right, plane has drifted to the south, in which case a new heading should be flown.

14. Fly a heading of 300 degrees. This will put plane back on desired track of 270 degrees. To allow for a wind drift now turn back to heading of 280 degrees.

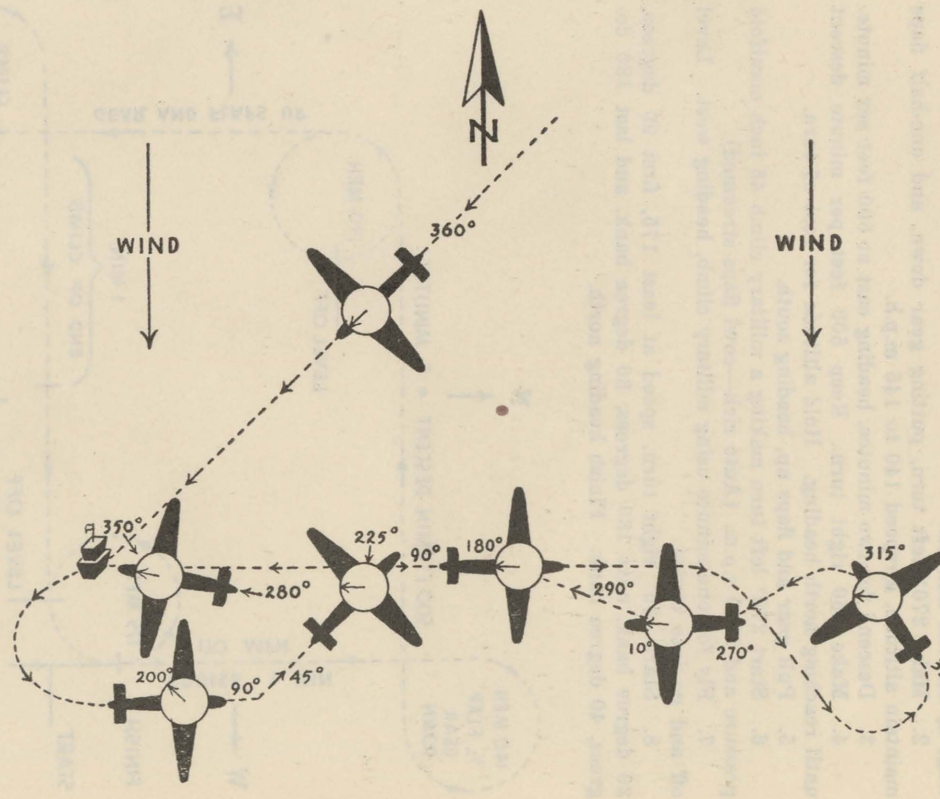
15. This will allow for a drift of 10 degrees. Plane is on track as long as needle points to 350 degrees.

16. Continue to station until passing over as indicated by needle turning 180 degrees.

17. The above is accomplished by the use of the true bearings of station from plane.

(a) The sum of the heading and relative bearing is true bearing of station from plane.

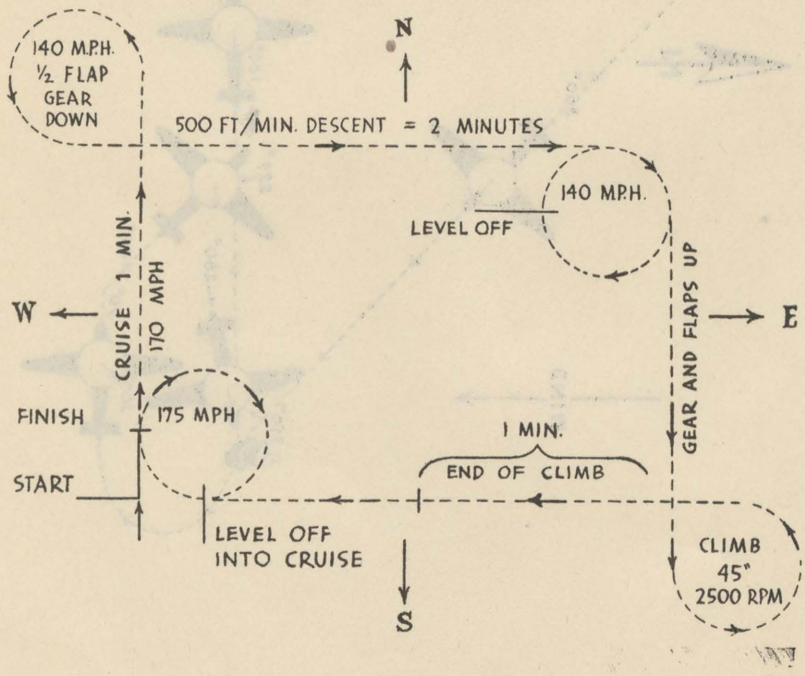
(b) The desired course subtracted from the preeent heading gives the relative bearing necessary to place plane on course.


N
WIND
WIND
360°
A
350°
280°
225°
90°
180°
290°
315°
315°
270°
10°
200°
90°
45°

PATTERN FOR INSTRUMENT PRACTICE

In the following pattern maintain headings within five degrees, and altitude within 100 feet. Strive to make all turns smoothly, using 20° banked turn unless otherwise specified.

1. Heading 360°, altitude above 5000 feet, plane in cruise setting, fly for one minute.
2. Make 270° left turn, putting gear down, and one-half flaps maintain altitude, airspeed 140 to 145 m.p.h.
3. Descend for two minutes, heading east at 500 feet per minute.
4. Make 450 right turn. Keep 500 feet per minute descent until reaching north heading. Hold altitude for rest of turn.
5. Pull gear and flaps up, heading south.
6. Start 270° left turn making a military climb 45 inch manifold pressure and 2500 r.p.m. (Auto rich—cowl flaps streamed).
7. Fly for one minute using military climb, heading west. Level off and go into cruise.
8. Start 450° right turn, speed at least 175, first 90 degrees, 20 degree bank, next 180 degrees, 30 degree bank, and last 180 degrees, 40 degree bank. Finish heading north.



LET DOWN PROCEDURE

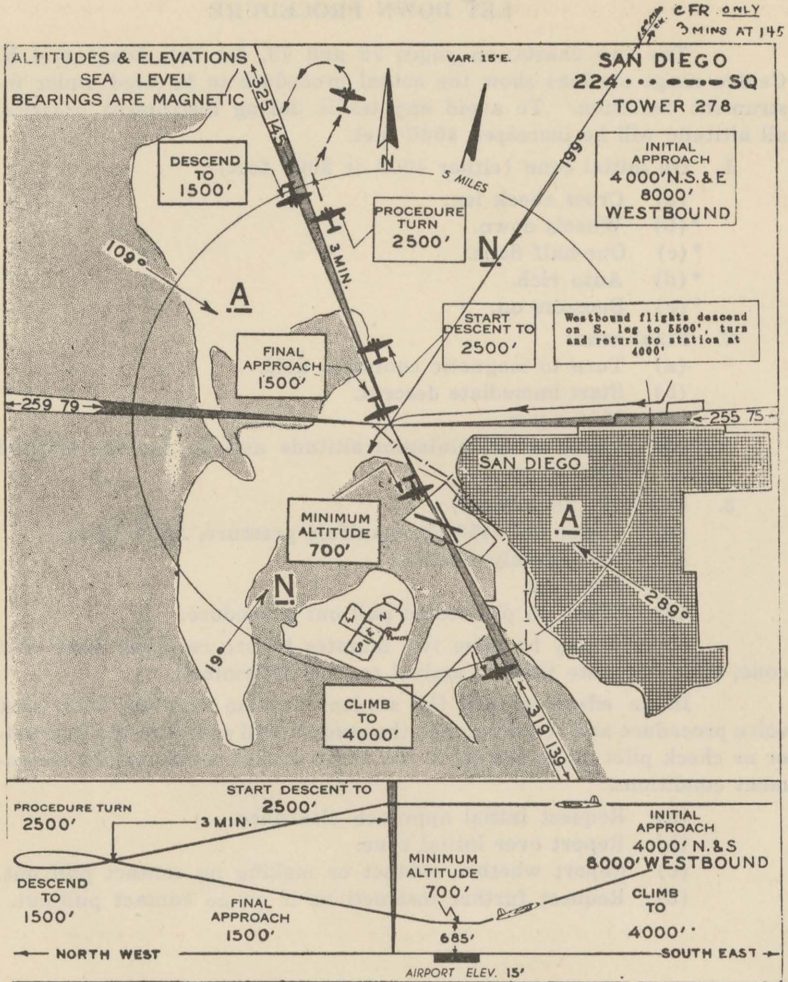
Tne two charts, on pages 72 and 73, for San Diego and El Centro range stations show the actual procedure to be used under instrument condition. To avoid any traffic during instrument practice, all altitude will be increased 4000 feet.

1. On initial cone (either 4000 or 8000 feet):
   - (a) Cross check leg.
   - *(b) Wheels down.
   - *(c) One-half flaps.
   - *(d) Auto rich.
   - *(e) Boosters on.
2. Final cone:
   - (a) Turn to magnetic course to field.
   - (b) Start immediate descent.
   - (c) 2500 r.p.m.
   - (d) Level off at minimum altitude and fly for the allotted time.
3. Pull out (no contact):
   - (a) Power on—45″ Hg manifold pressure, 2500 r.p.m.
   - (b) Immediately Gear-up.
   - (c) Flaps up.
   - (d) Climb on prescribed pull out procedure.

*b to e may be done two minutes before reaching 4000 foot cone, if an accurate time of arrival can be determined.

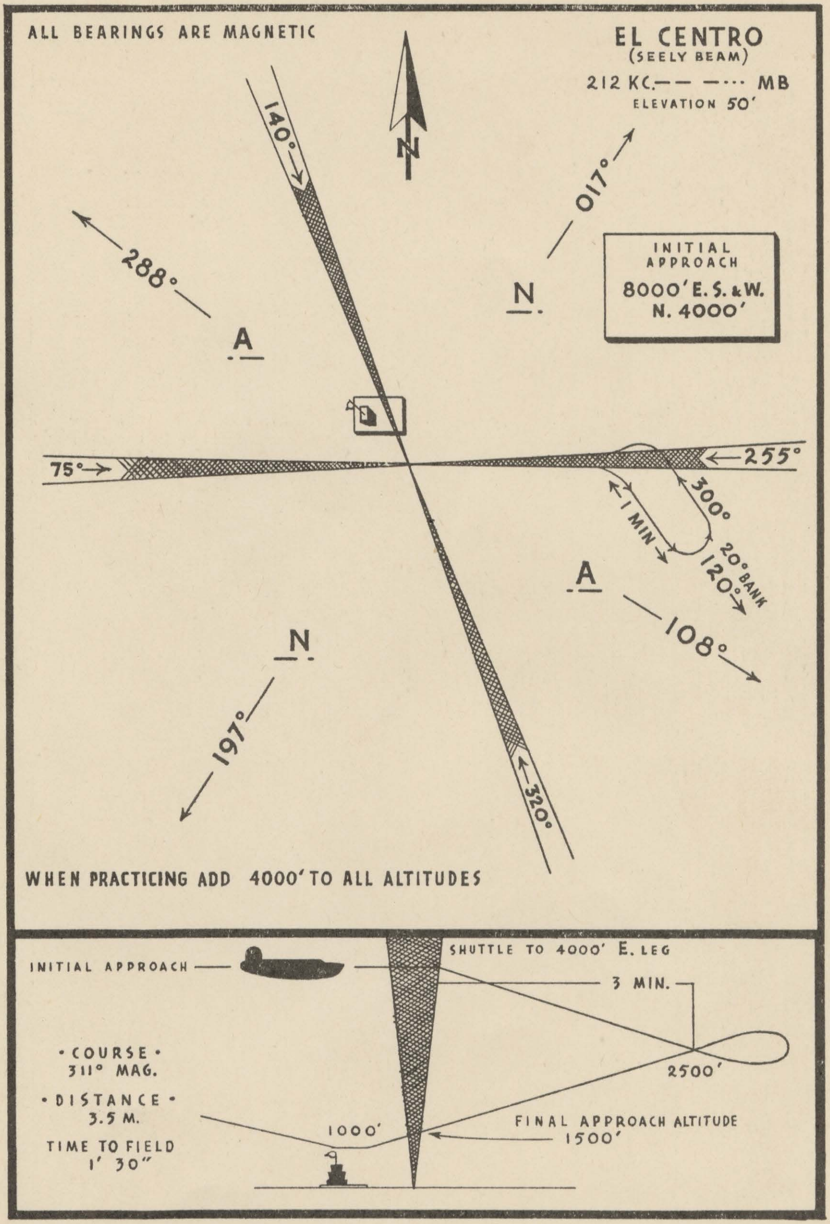
In an effort to help the student become familiar with CAA voice procedure and requirements, the student will report to the instructor or check pilot as he should to the radio station under actual instrument conditions.

- (a) Request initial approach clearance.
- (b) Report over initial cone.
- (c) Report whether contact or making no contact pull out.
- (d) Request further instructions if on no contact pull-out.



TO LINDBERGH	TO NORTH IS.	TO KEARNEY CFR ONLY
140 M.P.H.	140 M.P.H.	145 M.P.H.
1 MIN. 45 SEC.	1 MIN. 45 SEC.	3 MIN. 5 SEC.
145° M	160° M	015° M

WHEN PRACTICING ADD 4000 FEET TO ALL INDICATED ALTITUDES.


ALL BEARINGS ARE MAGNETIC
EL CENTRO
(SEELY BEAM)
212 KC. — — — ··· MB
ELEVATION 50'
N
140°
017°
288°
INITIAL APPROACH
8000' E. S. & W.
N. 4000'
N
A
75°
255°
300°
1 MIN
20° BANK
120°
A
108°
N
197°
320°
WHEN PRACTICING ADD 4000' TO ALL ALTITUDES
INITIAL APPROACH
SHUTTLE TO 4000' E. LEG
3 MIN.
• COURSE •
311° MAG.
2500'
• DISTANCE •
3.5 M.
FINAL APPROACH ALTITUDE
1500'
1000'
TIME TO FIELD
1' 30"

FORCED DESCENT OF LAND PLANES AT SEA

"DITCHING"

1. **General**—The following notes have been prepared by the British for the general guidance of all members of aircraft crews in event of a forced landing at sea, which they call "Ditching." Liferaft referred to in this Technical Order is called "Dinghy" in the following text.

2. **Preparation for Ditching:**

(a) If doubt exists in the captain's mind whether he can reach the coast, preparation for ditching MUST begin, particularly the radio procedure.

(b) If height cannot be maintained, above 1000 feet, the crew should move to their ditching stations in order that the pilot should be able to re-adjust trim, and lower his flaps without the crew moving about the aircraft.

(c) The executive order to prepare for ditching is "Dinghy, Dinghy, prepare for ditching" which must only be given by the captain. The order will be acknowledged by the whole crew by interphone with the answer "Navigator ditching ditching" or "Front Gunner ditching," whichever is appropriate. The crew should also have a pre-arranged call light ditching signal, and the letter "d" repeated three times is appropriate. The captain will normally warn the wireless operator in this manner, and the member of the crew nearest the wireless operator should also give him verbal warning. The preparation for ditching is thus begun on a coordinated basis, and the captain is assured that his crew is aware of the situation, and if they have practiced the drill, they know what to do, and do it.

(d) The captain's duty is to coordinate the work of his crew, but the crew should act on his executive order "Dinghy, dinghy, prepare for ditching" without further orders from him being necessary, other than his final order to the wireless operator to move to his ditching station, and the final warning of the impending impact.

3. **The Navigator:**

(a) Should have a constant appreciate of WS (wind speed) and D (direction) and Dr (drift) and fixed position. He should always be well aware of fuel consumption in relation to his ETA (estimated time of arrival).

(b) On the captain's executive order, the navigator will:

1. Calculate position.
2. Pass DR position to W.O with course, height, and speed maintained.
3. Receive fixes and bearings from W.O.

4. Calculate estimated position of ditching and pass to W.O.
5. Inform captain of surfaces WS and D.
6. Make out air and dinghy release pigeon messages.
7. Destroy secret papers and place charts (with latest positions marked thereon) in satchel.

4. **Wireless Operator:**

On the captain's order "Dinghy, dinghy, prepare for ditching" the W.O. will:

(a) If on group frequency make the first signal on that frequency and then change over to the allotted MFDF section.

(b) Turn IFF to emergency.

(c) According to the situation use one of the three priority calls:

1. S.O.S I am in immediate need of assistance. May Day (by Radio Telephone).
2. I may require assistance.
3. I may be forced to land without further signal.

(d) Give a time and position to the signal. It is better to make one of the distress signals as appropriate, than to remain silent. A distress can always be cancelled when no longer applicable, and in fact, this must be done.

(e) Transmit course, height and ground speed maintained.

(f) Pass fixes or bearings to navigator.

(g) Receive estimated position of ditching from navigator.

(h) Transmit estimated position of ditching.

(i) Clamp down key on captain's order and move to ditching station.

(j) Destroy secret papers.

(k) Where possible use the trailing aerial as an altimeter.

5. **It is the personal responsibility of the captain:**

(a) To insure that the bomb doors are opened, the bombs and containers jettisoned, and the doors closed again. It takes time to open and close doors, and if there is any doubt that there is time to do this it is better to keep doors closed; in this case it is essential for the captain to check that the bombs are "safe."

(b) To decide whether to jettison fuel; the member of the crew detailed in the drill then opens the cocks on the captain's order. When the fuel is jettisoned it is imperative that the cocks should be closed to retain buoyancy of the tanks. Jettison cocks take time to open and close; the fuel can seldom be jettisoned faster than 100 gallons per minute.

NOTE: Most U.S. airplanes are not equipped to jettison fuel.

(c) To insure that the member of the crew detailed in the drill, assists him to secure his **sutton** harness.

(d) To jettison the pilot's upper exit.

(e) To check that the undercarriage is UP.

(f) To lower flaps to the ditching setting.

(g) To order the Wireless Operator to his ditching station, since it is important to remain at the set as long as possible.

(h) To warn the crew when ditching is imminent.

(i) To switch on the landing lamp and the upper identification lamp, (if this does not cause reflections which upset vision). It is important to remember that judgment of height may not be correct.

6. **Preparation of the Aircraft to make it as seaworthy as possible.**

(a) Not only does jettisoning the fuel lighten the aircraft and so reduce the speed at which the aircraft can be ditched, but also the empty fuel tanks are a considerable contribution to flotation.

(b) The security of all lower and side hatches must be checked. Side exits may have to be used as ditching exits, but only upper exits can be regarded as ideal, since they must be opened before ditching. This is necessary because the hatches may become jammed on impact and also because it is essential for the crew to be free to leave the aircraft without delay after ditching.

(c) The bombs should be jettisoned to lighten the aircraft to assist in reducing the airspeed at impact, and this loss of extra weight will contribute considerably to flotation. If there is any danger of the doors being open when the aircraft hits the water, it is better to keep the bombs on board "Safe." Thirty seconds must be allowed for opening and closing of bomb doors.

NOTE: Insure that when equipment is jettisoned it does not hit the tail plane or carry away the I.F.F. aerials. If airplane has full droppable fuel tank, drop it. If droppable tank is empty retain it for flotation.

(d) All bulkhead doors must be closed to hinder the flow of water from bow to stern.

(e) Close all camera hatches and flare chutes.

7. **Preparation by the Crew to insure safety on and after impact:**

(a) All the actions to make the aircraft seaworthy also come into this category.

(b) It is vitally important that the crew should be braced against the impact. There are two ideal ditching stations.

1. In a sitting position, back and head braced against a solid structure, such as at the rear of a spar, an armored door or an armored bulkhead. If the head

comes above a spar being used as a ditching station, it is very important that the head should be clasped in the hands, to avoid its being forced back and injured. In this position the body can withstand forces which are far greater than those expected in ditching with the exception of forces expected when the aircraft dives straight in.

2. The second but less satisfactory ditching station is to lie upon the floor with the head to the rear and the feet braced against a solid structure. It is necessary to have the knees bent to avoid injury as far as possible, but the limiting factor of this ditching station is the liability of the legs to fracture.

(c) Straps are not normally required at ditching stations unless there is a lack of suitable positions in the aircraft when the member of the crew may have to remain in his seat. Loss of life may occur due to failure to get clear of the aircraft so that strap must not be used unless virtually necessary.

(d) It is vitally necessary for the pilot to be secured by sutton harness, and it is considered that the embarrassment caused by having the harness done up during ditching is far less serious than the consequence of not being secured.

(e) The rear step formed by the end of the bomb cell should not be used as a ditching station, since a great rush of water is expected here, owing to the almost certain collapse of the bomb doors and consequently the step will be liable to burst inward.

(f) All forward and amidship upper hatches should be opened before ditching to facilitate the rapid egress of the crew, and also to insure that the hatches do not become jammed on impact due to being left closed. It should, however, be borne in mind that open hatches cause drag and, therefore, the aircraft should not be opened until at leat 1000 feet is reached.

(g) In night ditching all bright internal lights should be put out and only the amber lamps used. This will accustom the eyes to the external darkness.

(h) All lights should be left on after ditching to facilitate search, in the event of the aircraft floating for a period.

(i) Life jackets must be worn at all times with the leg strips secured. Where there are small upper ditching exits, jackets should not be inflated till immediately after leaving the exit. On aircraft with large upper exits the jacket may be inflated before the ditching takes place. In most cases it is safe to inflate the jacket with one or two breaths before ditching.

(j) Parachute harnesses should be removed before ditching in all cases where practicable, except where the single-seater dinghy is attached to the parachute harness.

(k) Helmets should be retained for the sake of protection of the head against cold when in the dinghy. The leads should be tucked firmly within the life jacket before the V of the neck at the top tie.

(l) The latest aircraft sea rescue equipment is usually stowed in either the dinghy stowage or conveniently near the ditching exits, and it should not be removed from these stowages before ditching to avoid its being flung forward on impact and becoming lost in the surge of water. That equipment which is carried free must be held firmly during ditching.

8. **Wind speed and direction and surface conditions in relation to ditching.**

(a) At least an elementary understanding of sea conditions must be gained to obtain full advantage from the notes on handling, which follow this section. It should be remembered that Fleet Air Arm and boat pilots are continually associated with the sea, and have therefore, a decided advantage over the landplane pilot who usually has not that experience.

(b) **Calm Sea**—With this type of sea there may be little or no wind, so that it is essential to ditch with the lowest IAS possible. Such a sea is deceptive with regard to judgment of height particularly if the surface is "glassy." If there are ripples upon the surface judgment of height is improved.

(c) **Waves** always move with the wind except when close in-shore, and in fact flowing estuaries. Waves are the direct result of the wind which creates and maintains them.

(d) **Swell** is an undulating movement of the surface caused by past or distant disturbance by action of the wind. It does not necessarily move with the wind, and it has no breaking crests. If the wind is blowing across the swell, a cross-sea is created with the waves (which are moving down-wind) running on the swell. In these conditions the pilot must choose that direction along the swell which will make the approach as near into the wind as possible.

9. **Ditching Characteristics**—If the aircraft lights tail down in a three-pointer attitude (as it should) there will be a primary slight impact as the rear of the aircraft strikes. This will be followed by a severe impact with violent deceleration in most cases. If the alighting has been made too fast a bounce will occur, providing the underbody is sufficiently strong. As the aircraft comes to rest the nose will bury, but if the alighting has been carried out correctly, the effect of the

nose burying will be minimized, and the structure may not collapse. Usually bomber aircraft may be expected to float for a minimum per. iod of one minute.

10. **Characteristics in a Short, Moderate or Calm Sea:**

If the aircraft bounces, the control column should be held back. In the average short sea the tail should touch the crest of a wave and as soon as it does the nose should be kept up as much as possible. This should cause the forebody to touch down approximately under the CG on the next wave crest.

WARNING: The open sea always appears from the air to be much more calm than is the case.

11. **Wind Speed and Direction:**

(a) In the absence of any fixed mark (land, lightship, etc.) or floating object not under way, the pilot can only judge motion relative to the motion of the waves.

(b) Waves, as distinct from swell, move down-wind, and the line of the wind can be taken to be at right angles to the line of the wave crests; but doubt may exist as to which way the wind blows along the line.

(c) If there is sufficient wind, waves break, and they break down-wind. This can readily be observed from a low height. If the aircraft is flown at right anges to the breaking waves the direction of drift will be apparent.

(d) If there is enough wind to blow the spray off the wave crests, the direction in which the spray moves is reliable.

(e) Wind direction may be obtained by dropping a smoke float. The smoke from ships is also a useful guide. Smoke naturally drifts with the wind and if this drift could be observed, the direction would be indicated. But do not make the mistake of supposing that the wind direction is along the trail of the smoke. This trail is the resultant of the wind speed and direction and the ship's forward motion. Therefore, the wind direction is somewhere between the forward path of the ship and the smoke trail. Only when the wind is blowing in a similar direction to the forward motion of the ship will the smoke be a reliable indication of direction. It will be from astern.

(f) If low enough, it is possible to calculate the direction of the wind by observing the sails of surface craft. A reasonable indication of speed can also be gained by observing the set of the sails.

(g) Where the surface is not broken up it is possible to watch gusts rippling the surface in great sweeps, which indicate wind direction.

12. **Drill During the Final Approach:**

(a) The captain should keep his wireless operator at the set as long as possible and only leave him a safe margin of time to take up his ditching station.

(b) The crew on their part must see to it that the wireless operator's station is not occupied and is clear of obstacles.

(c) The captain will warn the wireless operator to move to his ditching station by call light and/or interphone or by shouting.

(d) The wireless operator for his part can be fairly certain that the order will come when he feels the flaps finally being lowered.

(e) The wireless operator will immediately clamp down the key and move to ditching station on the captain's order, fully realizing that he has been left at the set only as long as it is safe, thus if he does not move quickly he may be caught standing up at impact. This is very dangerous.

(f) The captain will maintain intercommunication with the crew up till the last moment, and warn them of the impending impact. It is not reasonable to expect a crew to remain braced for long periods. If they are not in intercommunication with the captain, the temptation to get up and see how things are progressing may end in being caught out of a ditching station with consequent injury. A casualty in ditching is a very grave handicap to the rest of the crew, who may scarcely be able to save themselves.

13. **Drill During Ditching:**

(a) The crew must not relax or release themselves in their ditching stations until the aircraft has come to rest. The first impact of the tail can be mistaken for the shock against which they are on guard, but it will be followed by a greater shock as the nose strikes the water after a correct three-pointer tail-down ditching.

NOTE: Serious casualties have occurred in crews who have not taken up proper ditching stations or where they have relaxed before the final impact. Also, some crews have thought they knew better ditching stations than those laid down in the official drill; this also has resulted in casualties. It is pointed out that these drills are the result of experience of a great many previous ditchings and are drawn up by Air Sea Rescue with the advice of operational pilots of squadrons, groups and commands and by technical officers of the Ministry of Aircraft Production. Such advice and instructions should not be lightly disregarded.

(b) Aircraft may slew to one side after impact, especially after a down-wind or cross-wind ditching. In most dinghy drills the ditching stations provide for this contingency in various ways.

14. **Handling of Landplanes in Ditching:**

(a) Use of Flaps—the flaps should be lowered to reduce the speed at which the aircraft can approach and touch down. It is better to use a medium setting and not to lower them fully because little, if any, further reduction of speed is obtainable by so doing, while the rate of descent is increased and the aircraft approaches more nose down; a steep nose down descent is dangerous if the sea is met sooner than expected, and also more height is required for flattening out from such an attitude.

NOTE: The maximum flap deflection for the B-24C, D and E airplane is 40 degrees, at which position the wing lift increase is 55 percent and the drag increase is 70 percent. At the position of 20 degrees down the lift increase is 24 percent and the drag increase amounts to 30 percent.

(b) Approach Speed—Assuming that symmetrical power is not available for the normal glide, approach speed should be used. This will insure control and some margin of speed after flattening out to allow the pilot to choose the best spot for ditching on the swell.

(c) Touch Down—Apart from choosing the best point at which to ditch, the pilot should hold off until he loses all excess speed above the stall and so strikes the sea at the normal three-point landing attitude (slow landing attitude for tricycles). The best point for ditching is towards an oncoming swell top.

(d) Direction of Approach in a Swell—In a steep swell the pilot should generally ditch along the top of the swell. He should ditch up-wing in a long ocean swell; however, if ditching along the swell would involve alighting with a very strong cross-wind, the aircraft should be ditched into wind. In ditching across the swell, the aircraft should be put down on an upslope towards the top.

(e) Ditching Across Wind Along a Swell—As the sea is approached, drift should be taken off by sideslipping, and the aircraft ditched on the upslope of the swell.

(f) **Use of Engines:**

1. If one engine of a twin-engine aircraft is available, a little power should be used to flatten the approach; but the engine should not be used to such an extent that the aircraft cannot be turned against it right down to the stall, with a margin of rudder power in hand. On no account should the engine be opened up during the final stages of ditching. The power that can be used will depend on the characteristics of the airplane.

2. If two engines are available on one side, the inner engine only should be used.

3. If the power is, for instance, inner port and outer starboard, it will be possible to use considerable power, adjusting the throttles so that little rudder is needed; this case approximates to the next case.

4. If power is available symmetrically, it should be used—to full, if necessary, with two engines out of four—to secure the flattest possible approach and the slowest possible touchdown. The slip-streams over wings and tail will aid considerably in reducing speed and retaining control.

15. **Retention of Fuel for Ditching**—The value of power in ditching is so great that the pilot should always ditch before fuel is quite exhausted, when it is certain that land cannot be reached.

16. **Altimeter**—The aneroid altimeter is quite unreliable as an indicator of close approach to the sea. The trailing aerial can be used, the wireless operator signalling the captain when the current drops on the weight hitting the sea. An alternative method is to engage the aerial with an insulated hook in the hand, when the impact of the weight on the sea will be felt. This drill can only be carried out where a suitable ditching station is adjacent to the W.O.

17. **Drill After the Aircraft Has Come to Rest:**

NOTE: There are two critical periods in ditching:

The actual handling of the aircraft onto the water. This is the sole responsibility of the pilot.

The abandonment of the aircraft in an orderly manner after ditching in the very shortest time possible. This cannot be done well in a training fuselage in a hangar without much practice. Far less can it be expected to carry out an efficient drill in the dark after a shock in a fuselage which is filling with water UNLESS the drill is perfect. Practice makes perfect. A very large number of crews have thus saved themselves and finally have been rescued by surface craft.

(a) The crew must not release themselves until the aircraft comes to rest.

(b) Most multi-engine aircraft now have automatic release of the dinghy, but do not depend solely upon this because the mechanism may have been damaged. Operate the manual release of the dinghy as soon as the aircraft comes to rest **but not before.** The manual release should not be gripped before or during the ditching to avoid inadvertent release as a result of the impact. If this mistake is made the dinghy will blow out while there is still way on, and it may thus break free and drift out of reach.

(c) Directly the aircraft comes to rest, rise from the ditching stations and collect that equipment detailed in the drill. Leave by the hatch detailed in the drill and in the correct order, carrying that equipment allocated to each member of the crew. When the dinghy radio is carried remember that it, and the means of erecting the aerial (mast or kits) are the most vital pieces of equipment required in the dinghy to assist rescue; the pigeons are next in importance and the food last but not least.

(d) On emerging, inflate the life jacket if not already done. Do not be surprised to find that waves may be breaking over the aircraft. If they are large it is possible to get swept off. If the aircraft has a life line attached to the inside of the hatch, make use of it, otherwise hold on to the outside of the hatch and await a favorable moment to board the dinghy, but by doing so take care not to block the escape hatch, or to hinder the tempo of the drill to any great extent.

(e) In aircraft with blow-out dinghies, one man is detailed to assist the dinghy from the stowage, and it is his duty to see that the necessary cordage does not entangle during inflation. He should also assist the dinghy into the water in order to hasten the boarding.

(f) If the dinghy should inflate inverted, an endeavor should be made to right it from the wing, if the aircraft is not sinking rapidly; otherwise one (and one only) of the crew should jump into the sea and right it. There are two methods of doing this:

1. If there are handling patches on the bottom of the dinghy, grasp them with both hands. Then haul on these patches with knees on the buoyancy chamber. Now while still hauling on the handling patches lean back and prepare to become submerged for a moment. The dinghy, even the largest, will turn over.

2. In the absence of handling patches, place the toe of the foot on the bottom of the ladder, grasp the two nearest stabilizing pockets. Lean back and haul on the pockets while pressing with the foot on the ladder.

(g) Do not jump onto the inverted dinghy, as doing so expels air trapped beneath it, and makes righting more difficult.

(h) If there is a painter which attached the dinghy to the aircraft, it is made intentionally light in order that it shall break if the aircraft sinks while the dinghy is still attached. There is a floating knife attached to the dinghy near the point where the painter is made fast. This knife is to be used to cut the dinghy free.

18. **Boarding the Dinghy:**

(a) If the ditching has been made into the wind, the dinghy should float toward the tail plane, and the boarding should not be difficult.

(b) If a cross-wind ditching has been made, the aircraft will tend to swing into the wind. If the dinghy is on the up-wind side of the aircraft, there is danger of it becoming wedged beneath the wing as the aircraft rolls and swings into the wind. On the other hand, if the dinghy is on the down-wind side, there is a danger of getting beneath the fuselage or tail plane which may be thrashing up and down, as the aircraft weather-cocks into the wind. Look out for jagged edges which may puncture the dinghy.

(c) Do not jump into the dinghy; by so doing it may become damaged and the whole crew endangered.

(d) If boarding from the sea, use the rope ladder, or the tail line, if provided. When using the ladder, grasp the ratlines (which run across the dinghy) with one hand and the bottom rung of the ladder with the other, pushing it down into the water as far as it will go to assist in inserting the foot. Then grasp the ratlines with both hands and pull, at the same time pressing downward with the foot.

(e) One man already in the dinghy can be of great assistance to those in the water who require helping aboard.

(f) To avoid the consequences of exposure, it is important not to get more wet than absolutely necessary. But wet clothing must NOT be taken off; it is far warmer with wet clothes on than off. In hot weather this may not apply, so far as cold is concerned, but the body should be covered against the sun.

(g) On every main dinghy there is a heaving line which may be used for aiding crews to reach the dinghy.

(h) All the above actions concerning boarding the dinghy are comparatively simple if the life jacket is fully inflated. If this jacket has been partly inflated by mouth, it is important to be sure that the mouth valve is closed before using the CO_2 bottle. A non-swimmer can feel quite confident in a fully inflated jacket, providing the leg straps are secure.

19. **Aboard the Dinghy:**

(a) Once aboard it is the duty of the man detailed in the drill to check whether there are any leaks, and stop them up with the stopper provided. Another member of the crew is also detailed to connect up the topping-up bellows and top-up until the dinghy is rigid. If any of the crew are in the water the topping-up of the dinghy will greatly assist in boarding.

(b) Once every one is aboard, the captain should call the roll and give the order to cast off, then the crew should paddle away from the aircraft. If the aircraft floats, keep nearby to increase the chance of being spotted. But do not remain made fast to the aircraft where there is any chance of the dinghy being punctured or in rough conditions where the dinghy is likely to be damaged by the rise and fall of the aircraft.

(c) The dinghy cover should next be rigged with the assistance of the whole crew.

(d) Once the dinghy cover is rigged, bailing should start to clear out most of the water.

(e) **Emergency Operation of Radio Equipment:**

1. **Operation of Portable Emergency Radio Transmitter (Type SCR-578-A).**

(a) **General:**

A complete self-contained portable emergency transmitter is provided for operation anywhere away from the airplane. It is primarily designed for use in a small boat or life raft, but may be placed in operation anywhere a kite can be flown, or where water may be found. The unit is usually stowed in the aft end of the radio compartment next to the transmitter tuning units, and is equipped with a small parachute to permit dropping from the airplane in event of any emergency.

When operated, the transmitter emits an MCW signal, and is pretuned to the international distress frequency of 500 kc. Automatic transmission of a predetermined signal is provided. Any searching party can "home" on the signal with the aid of a radio compass. No receiver is provided.

(b) **Removal from Airplane:**

If the airplane has made an emergency landing on water, the emergency set should be removed at the same time that the life raft is removed. The set is waterproof, and will float, and therefore it is not necessary to take any precautions in keeping the equipment out of the water. Be sure that it does not float out of reach.

The emergency set may be dropped from the airplane by use of the parachute attached. The altitude of the airplane when dropping the equipment should be between 300 and 500 feet. To drop the equipment, the following steps should be observed:

Tie the loose end of the parachute static line to any solid metal structure of the airplane.

CAUTION: Be sure the static line is in the clear and will not foul.

Throw the emergency set out through a convenient opening in the airplane. Parachute will be opened by static line.

CAUTION: Do NOT attach static line to any part of one's body when throwing the equipment through the opening.

(c) Operation—Complete operating instructions are contained in one of the bags which contain the equipment. Complete instructions for the use of transmitter are also located on the transmitter itself.

2. Interphone Equipment Failure—In the event of interphone equipment failure, the audio frequency section of the command transmitter may be substituted for the regular interphone amplifier. To make this connection, the pilot should place his command transmitter control box channel selector switch in either "No. 3" or No. 4" position. Set the interphone jackbox selector switch on "COMMAND" to place the interphone equipment in operation.

NOTE: When the command transmitter control box channel selector switch is set in either "No. 3" or "No. 4" position for emergency operation of the interphone equipment, it is not possible to establish communication with any station or any other airplane. It is possible at all times to resume normal command set operation by placing the channel selector switch of the command transmitter control box back in either "No. 1" or "No. 2" position.

3. **Substitution of Radio Compass Receiver for Low Frequency:**

Command Set Receiver—If the low frequency receiver of the command set fails, the radio compass receiver may be substituted, with the pilot having **direct control** over the compass receiver. To complete this emergency hook-up, the pilot must set his interphone jackbox selector switch in the "COMP" position and then place the radio compass selector switch (marked "OFF," "COMP," "ANT," "LOOP") in the "ANT" position. The radio compass can then be tuned as desired.

4. **Substitution of Liaison Receiver for Low, Medium and/or High Frequency Command Receiver**—In case of failure of the low, medium and/or high frequency receiver of the command radio equipment, the liaison receiver may be substituted, but the pilot will have only limited control over it. The pilot should first call the radio operator on the interphone system and tell him what frequency he desires to receive, that he is switching the interphone selector switch to the "LIAISON" position, and for him (the radio operator) to tune in this frequency and maintain the setting until further advised.

NOTE: When substituting one receiver for another, such as the compass receiver for the command receiver, the pilot must move his interphone jack box switch to the "COMMAND" or "LIAISON" position in order to transmit. At the end of the transmission, he must switch back to the position of the receiver being used. This will have to be done every time that the pilot desires to hold a two-way conversation.

5. Command Set Transmitter Failure—In case of failure of the command set transmitter, the liaison transmitter may be substituted. The pilot should first call the radio operator on the interphone and have him adjust the liaison transmitter to the frequency he desires to use. He should then set his interphone selector switch to "LIAISON" position and operate his microphone button in the same manner that he did when the command set was in operation. When he is through using the liaison transmitter, the pilot should place the interphone selector switch in the "INTER" position, and tell the radio operator to cut the liaison transmitter off so as to reduce the load on the electrical system.

FLIGHT TRAINING

Prior to flight, student pilot is given a cockpit check out shown on Page 1. After this check out student pilot rides eight (8) hours in center seat as an observer. Upon completion of the observation rides, the student is ready for the following flight training.

PHASE A—BASIC TRAINING

Phase A-1 (2 hours)

Solo students—Right seat: Co-pilots—Right seat.

Instructor explains or demonstrates: stalling characteristics, check off lists, emergency procedures, engine failures, radio equipment, AFC (C-1) operation, gas system, autosyne instruments, fuse boxes, pre-flight check, and general flying characteristics under various conditions. This flight is conducted above 7000 feet with the student occupying the right seat.

Phase A-2 (2 hours)

Solo students—Left seat: Co-pilots—Right seat.

1. Normal landings.
2. Emergencies.
   - (a) Cut gun (No. 1 or No. 4) on take-off.
   - (b) Simulate feathering (15" Hg at take-off).
3. Engine failure in flight.
   - (a) No. 1, No. 2, No. 3 or No. 4.
   - (b) Go through entire feathering procedure.
4. Emergency or full-power pull up.
5. Methods of lowering gear (4).
6. Methods of lowering flaps (4).

Phase A-3 (2 hours)

Solo students—Left seat: Co-pilots—Right seat.

1. Normal landings.
2. Full flap no power landing.
3. Three engine landing.
4. No flap take-off.
5. Full flap take-off.
6. Emergencies.

Phase A-4 (2 hours)

Solo students—Left seat: Co-pilots—Right seat.

1. Normal landings.
2. Short field landing and approach.
3. Closed field landing and approach.
4. No flap landing.
5. Emergencies.

Phase A-5 (2 hours)

Solo students—Left seat: Co-pilots—Right seat.

1. General review.

Phase A-6 (4 hours)

Solo students—Left seat: Co-pilots—Right seat.

1. General review for unqualified pilots if required.

Phase A-7 (2-4 hours)

Solo X for solo students (left seat) only.

1. Pre-flight check.
2. Cock pit procedure and radio operation.
3. Taxiing, run up, and ramp procedure.
4. Take-offs:
   (a) Normal or ½ (20°) flap.
   (b) Full flap (40°).
   (c) No flap.
5. Landings:
   (a) Normal.
   (b) Full flap (40°)—no power.
   (c) No flap or half (20°) flap.
   (d) Small field.
   (e) Low visibility.
   (f) Three engines.
6. Emergencies:
   (a) No. 1, No. 2, No. 3, or No. 4 out in flight.
   (b) No. 1 or No. 4 out on take-off.
   (c) A.C. power and fuel off to one engine.
7. AFC (C-1) operation.
8. Aptitude and Airplane Commanders' Technique.

NOTE: Co-pilots are not given a check as their respective instructors qualify them when ready, but are not to utilize more time than allotted. After qualifying, they fly as co-pilots for solo students until their flight time is approximately forty (40) hours.

Phase A-8 to A-11

1. The above phases take care of extra time and re-checks.

Phase A-12 (10 hours)

1. **Basic solo.**

PHASE B—INSTRUMENT TRAINING

This instrument course is to familiarize the student with the handling of the plane on instruments and to completely familiarize the student with the radio equipment in the plane.

The limited time of this course will not allow for much basic instrument instruction, but if time permits, the instructors will do their best to help any student with his basic instrument flying.

The student should strive to smooth out his instrument flying during the short time allotted, and then to familiarize himself with all the radio equipment in the plane and the uses to which they may be put.

Phase B-1 (2 hours)

Basic Instrument Instruction

During basic instrument instruction and solo the student should strive to maintain his flight within the following tolerances:

Altitude + or — 150 feet.

Heading + or — 5 degrees.

Rate of climb + or — 300 feet per minute from the desired rate of climb or descent.

Air Speed + or — 5 m.p.h. from desired airspeed.

Degree of Bank + or — 5 degrees from desired amount of bank.

When turning to a heading stop plane and hold heading within 5 degrees of desired headings.

1. Explain how to check all flight instruments before take-off.
2. Climb to altitude (constant power).
   - (a) Hold a heading for 5 minutes.
   - (b) Twenty degree banked turn to right and left (180°).
3. Level flight (cruising).
   - (a) Hold heading and altitude for 5 minutes.
   - (b) Twenty (20°) degree banked turn to right and left (90°).
   - (c) Thirty (30°) degree banked turn to right and left (180°).
   - (d) Forty (40°) degree banked turn to right and left (180°) at least 175 m.p.h.

4. Attitude flight.
   (a) Lower gear—150 m.p.h. maintain heading and altitude.
   (b) Lower flaps to ½—140 m.p.h. maintain heading and altitude.
   (c) Twenty (20°) degree banked turn to right and left (90°).
   (d) Descend 1000 feet at 300 FPM.
      1. Hold heading for 2 minutes.
      2. Make twenty (20°) degree banked turn to right and left.
   (e) Level off and make full power pull up.
      1. Climbing power.
      2. Gear up.
      3. Stream cowl flaps.
      4. Flaps up.
      5. Climb on desired heading.
   (f) Turn on A.F.C. power switch.
   (g) Go through basic instrument pattern.
5. Three engine operation.
   (a) Cut one engine (feather).
      1. Straight and level flight.
      2. Twenty (20°) degree banked turn away from feathered engine .
6. A.F.C.
   (a) Engage A.F.C. on any desired heading.
   (b) Make ten (10°) degree course change to right and left.
   (c) Make eighteen (18°) degree banked turn to right and left coming out on given headings.
7. Radio Instruction.
   (a) Explain operations of manual loop, adjusting volume control to obtain bearings and procedure for loop orientation, use of "Voice—CW" switch, and use of rain static position.
   (b) Explain use of automatic loop, method of using loop to maintain a given track to and from radio station.
   (c) Explain fade parallel system of orientation and the full procedure for range let downs, gear down, half (20°) flap after getting initial cone.
8. Explain use of oxygen equipment.

Phase B-2 (6 hours)

Basic Instrument Practice (Solo)

First two hours (Basic):

1. Climb to altitude using 35″ Hg manifold pressure—2300 r.p.m.
   (a) Hold constant heading (5 minutes).

(b) Twenty (20°) degree banked left and right turn (90° turn).

2. Level off (holding altitude and heading for 5 minutes).

(a) Practice turning (20° banks) to right and left and coming out on definite headings holding these headings for 3 minutes (altitude plus or minus 100 feet. Heading plus or minus 5 degrees).

(b) Same for thirty (30°) degree banked turns.

(c) Practice lowering gear and flaps to one-half. Hold heading and altitude.

(d) Raise gear and flaps. Hold heading and altitude.

3. Practice basic instrument pattern. (Go through complete pattern twice.)

Second two hours (Basic):

1. Climb to altitude using 35″ Hg manifold pressure—2300 r.p.m.

(a) Hold constant heading (5 minutes).

(b) Twenty (20°) degree banked left and right turns.

2. Practice basic instrument pattern (go through twice).

3. Set up automatic flight control (C-1 auto pilot).

(a) Make small course changes to right and left.

(b) Make large (over 50 degree) turns to right and left coming out on definite headings.

4. Practice taking bearings (manual loop) on both radio ranges and radio broadcasting stations. Check bearings by turning radio compass to "COMPASS" position.

5. Fly by station (to right or left) taking continuous bearings as you pass stations.

Third two hours (Basic):

1. Practice all phases, especially any in which you feel that more practice is required.

Phase B-3 (2 hours)

Instrument and Radio (Solo)

Students will use oxygen during 6 hours of solo.

First two hours (Advanced):

1. Go through basic instrument pattern.

2. Make two complete manual loop orientations and home to station. (One on range station, one on radio broadcast station.)

3. Use both a radio range station and broadcast station to depart from station on a definite heading, and return to station on the reciprocal, using the automatic radio loop (one using A.F.C.).

4. Make complete fade parallel orientation and let down on range legs (don't go below 2500 feet if using San Diego range). Make no contact pullout.

Second two hours (Advanced):

1. Go through basic instrument pattern.
2. Make one complete manual loop orientation and home to station.
3. Make good a track of 70 degrees from range station, return on track of 250 degrees after making procedure turn to right. Use automatic direction finder only.
4. Make fade parallel orientation and two range let downs. (Keep above 2500 feet when using San Diego.) Each time make no contact pullout.

Third two hours (Advanced):

1. Practice all the above problems.
2. Practice the problem in which you feel the time could be spent most profitably.
3. Blank out A/H and D/G and fly a let down.

Phase B-5 (2 hours)

Instrument Check for Solo Students (Left Seat) Only

1. Instrument check prior to take-off.
2. Instrument take-off.
3. Climbing to altitude.
4. Warm up on basic pattern.
5. Manual loop operation.
6. Automatic direction finder operation.
7. A.F.C. (C-1) operation.
8. Radio range operation.
9. Three engine operation.

Phase B-6 to B-9

The above phases take care of extra time and rechecks.

Phase C-1 (2 hours)

Basic night check out.

1. Two landings (lights on).
2. Two landings (lights off).

Phase C-2 (2 hours)

BASIC NIGHT SOLO

1. Two landings (lights on).

2. Two landings (lights off).

Phase D-1 (4 hours)

DAY NAVIGATION HOPS

Phase D-2 (8 hours)

NIGHT NAVIGATION HOPS

NOTE:

1. Phase D-1 and D-2 have not been included in the syllabus as yet.

2. All solo students will log their solo time on board in crew flight training office immediately after flight. In addition they will log time for co-pilot on same board. See yeoman for details.

3. Transition Landplane Unit does not qualify pilots as to Patrol Plane Commanders, and Patrol Plane First and Second Pilots ratings, but qualifies pilots either to act as solo or co-pilot for Liberator (PB4Y-1) type aircraft. In this connection, after the instrument course has been satisfactorily completed a card is issued, i.e.,

"Qualified on instruments in 4 engine landplane."

"Qualified for let-down on instruments."

Engaging the system—After turning on the airplane's battery switches, the airplane's master switch, and one inverter switch, allow two minutes for the Amplifiers to warm up. The control system will then respond to the setting of the Turbo Boost Selector.

Taxiing—Turbo Boost Selector can be set at position "6" or slightly lower, according to power desired. Turn on filters.

Before Take-Off—Turn Turbo Boost Selector clockwise to "8". Set props to take-off r.p.m. Check manifold pressure on each engine separately at full throttle. If the manifold pressure on any engine fails to come up to within 1" of take-off pressure with full r.p.m., turn dial to zero and check the engine r.p.m. and manifold pressure without turbo boost. This will show whether the low manifold pressure is caused by faulty engine operation, or by insufficient turbo boost. **Be sure generators are turned on.** Also check D.C. voltage on voltmeter.

Take-Off—Turn Turbo Boost Selector dial to "8," and set throttles full open.

Climbing—After take-off, turn knob counter-clockwise until desired manifold pressure is reached. Decrease r.p.m to desired value. Reset manifold pressure with Turbo Boost Selector if necessary. Adjust intercooler shutters to maintain proper carburetor air temperature.

For climbing, after cruising, increase r.p.m. first; then increase MP to desired value by turning Turbo Boost Selector clockwise.

Cruising—Use dial to select manifold pressure. If manifold pressure cannot be lowered sufficiently with the knob, pull back on the throttles. Decrease r.p.m. to desired value, and then if necessary reset the manifold pressure with throttles and dial.

> **NOTE**—At least 2" of turbo boost should be maintained at all times to insure proper lubrication of turbo. If atmospheric conditions are such that carburetor icing may occur, maintain at least 4" of turbo boost and adjust intercoolers to maintain proper carburetor air temperatures. To arrive at the proper turbo boost, reduce MP 4" by retarding throttle, and bring MP back up 4" by increasing dial setting.

Emergency Power—Increase r.p.m. to maximum. Press dial stop release and turn dial clockwise to "10."

Formation Flying—The throttles, the Turbo Boost Selector knob, or the throttles and the knob combined ,may be used in formation flying, depending on the tightness of the formation, the position of the plane in the formation, and the altitude. In all cases, the Turbo Boost Selector must be set at a point where the manifold pressure will not exceed the recommended limit for the r.p.m. being used, even with throttles full open. At altitudes in the turbo overspeed range, the Turbo Boost Selector should be held to a setting below the point where the overspeed control begins to "cut in" on any engine, and the throttles should then be used to vary the power. Below 6,000 feet, the throttles must be used, as the effective range of the control system is limited at low altitudes.

Descending—Use the dial to select manifold pressure until throttle range is reached. For further reduction, use throttles.

NOTE—Turbo boost should be used when descending. Intercoolers should be closed to maintain carburetor air temperature.

Landing—Set props at maximum cruise r.p.m. Set dial at approximately "6." Pull back on throttles. Leave dial at "6" for taxiing.

NOTE—THROTTLES CAN BE USED TO OVERRIDE TURBO-SUPERCHARGER CONTROL SYSTEM AT ANY TIME.