# PRODUCTION FLIGHT TEST PROCEDURE FOR THE MARTIN B-26

# GENERAL INDEX



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Compiled and written by the Production Test Flight Section of The Glenn L. Martin Company, Baltimore, Maryland.


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*Chief Production Test Pilot*

# PART I
# FLYING REGULATIONS
# LAND PLANES

# FLYING REGULATIONS
# LAND PLANES

FUNCTION:

To prescribe flying regulations for company pilots.

AUTHORITY:

Operations Manager.

PROCEDURE:

1. All flying shall be:
   a. Under the direct control of the Operations Manager.
   b. Local in nature unless otherwise specifically designated.
   c. Contact and controlled both visually and by radio.
2. Contact flying shall have as minimums:
   a. Visibility 3 miles.
   b. Altitude 2500 feet.
   c. No precipitation of any kind shall be flown in except to return to the field in order to land.
3. Clearance:

   No flights of any kind shall be made without having first obtained a properly authorized clearance. (see S.P.I. 20.8, 26.14, 50.1).
4. No landings shall be made at any place other than the Martin Airport unless previous specific permission or orders directing such landings have been issued by the Operations Manager.
5. Traffic regulations:

   a. Airplanes landing shall have the right of way over all others.

   b. Approaches shall be made from the left and circling the field shall be accomplished in a left turn.

   c. No two airplanes shall be on the same runway at the same time, except by specific direction of the Control Tower.

   d. Airplanes shall not be warmed up, or "run-up" with tails pointed toward hangars.

   e. In run-ups on the runway prior to take-off, all airplanes shall be turned 90 degrees to the direction of take-off for run-up with the pilot downwind in order to observe the approach of traffic.

   f. Airplanes taking off shall have the right of way over taxiing aircraft.

g. Traffic shall turn to the left on take-off.

h. Pilots cleared for take-off or for taxiing to the line shall avoid unnecessary delays.

i. Under no conditions shall airplanes be flown over the city of Baltimore or adjacent restricted areas.

6. Airplane accidents on or in the vicinity of Martin Airport:

a. The Control Tower shall immediately notify the telephone operator who shall notify Messrs. Schurman, Martin, Hartson, Vollmer, Ebel, Rowland, Otto Jent and T. Young; the AAF Representative's Office, AAF Engineering Office in "K" Building, AAF Air Plant Protection Office if it is an Army airplane and the Resident Naval Inspector's Office if it is a Navy airplane.

b. The Operations Manager shall proceed immediately to the scene of the accident and assume complete charge until relieved by proper Manufacturing Personnel.

7. Nothing in these regulations shall relieve the pilot of full responsibility for the safety of his airplane. Instructions issued by the Operations Manager shall be considered as mandatory unless, in the opinion of the pilot, the safety of the airplane is endangered. In this event or in any emergency, the pilot shall use his own discretion in determining the procedure to be followed.

# PART II
# STANDARD PROCEDURE FOR LANDINGS AND TAKE-OFF INSTRUCTION

# STANDARD FLIGHT PROCEDURE

In an effort to standardize flight procedure in checking off new pilots and co-pilots, as well as visiting Army pilots, the following will be adopted until further notice as standardized practice on the B-26.

This may conflict with some of our little personal habits in flying and is not to be construed as condemning them as bad practices, but it is to avoid confusing pilots who may be with one instructor one day and another the next. This standard procedure need not be followed exactly when you are not instructing as long as there are no violations of flight regulations or what is considered good flight practice.

## Pre-Flight Inspection

This inspection is to be given under qualified co-pilots and flight engineers.

## Starting

Use Check List.

## Warm-Up, Engine and Propeller Check

Use Check List.

## Taxiing

Open throttles gently, allow airplane to roll straight ahead very slowly for approximately 10 feet. Apply both brakes slightly to test and immediately release. Start turn down ramp by starting outside engine and applying slight touch of inside brake.

All taxiing on the line will be done at a maximum speed of 5 MPH; i.e. at a speed at which the airplane would come to a stop immediately by cutting the engines alone. No excessive taxiing speed will be used at any time (unless in an emergency to clear the runway) except on regular taxiing run test.

Impress on the pilot you are checking off the importance of the nose wheel being straight ahead before running up the engines on brakes. Demonstrate close turns and how to recover from a flopped-over nose wheel smoothly.

## Take-Off

See that the ship is headed straight then advance throttles fairly rapidly but smoothly. Use unbalanced throttles in early part of take-off run to hold ship straight (no brakes should ever be applied on take-off run itself, except in emergency).

The use of throttles at this point is very important and it should be remembered that the proper procedure in correcting for "yaw" during take-off is to advance the throttles on the side towards the "yaw" rather than retarding the throttle on the opposite side. As soon as "yaw" is over-come advance both throttles evenly to allowable maximum take-off power, 51½" Hg. As soon as pilot is absolutely sure that no further contact with the ground will be made, signal gear "UP". At approximate time that gear is up reduce power to 45" Hg.,—2550 RPM.

### Climb

Flaps up at 145-150 MPH, then immediately reduce power to 38" Hg.—2400 RPM. Partially close cowl flaps (keep cylinder head temperature below 200°). Hold this power at 160-170 MPH until 1000 feet is passed then reduce to climbing power of approximately 32"–34" Hg., 2250-2275 RPM. Use 160 MPH as climbing speed. As head temperatures drop, close cowl flaps and oil cooler flaps as much as possible. Climb to desired altitude, level off, reduce power to 27"–28" Hg., 2100 RPM.

### Function Check

Use Section 4 on Allowable Limits and Tolerances.

### Landing

Descend to landing circle (2000 feet) using reduced power during descent. Call tower for landing instructions when not over 180° from expected landing direction. The speed at this time should be 180–200 MPH.

#### Down-Wind Leg:

When approximately opposite the runway that is to be used for landing with the I.A.S. of 165-170 M.P.H. the following check should be made:

Booster pumps "ON".
Propeller governors set at 2200–2250 RPM.
The landing gear handle "UP".
Hydraulic pressure normal, 850 to 1050 lbs. p.s.i.
18"–22" Hg.

#### Base-Leg:

150 MPH.
Gear "DOWN".

14"–18" Hg.
Pilot and co-pilot check each other that gear is "DOWN".
¼ to ½ flap.
Check hydraulic pressure.
Maintain 150 MPH during the 90° turn into final approach.

It is permissible to use the alternate flap method if so desired, which consists of using approximately ¼ to ½ flaps at 160–165 MPH on the base leg. Then throttle back to 15" Hg. and lower landing gear just before the 90° turn is made for the final approach. Use additional flaps as needed.

FINAL APPROACH:

The speed during the final approach should be between 135–145 MPH depending on the wind, load, obstructions, etc.

The power should be kept at some constant setting, (14"–18" Hg.), or as near as possible.

Use your flaps to spot the landing rather than throttles. However, this does not mean that throttles should not be used during the final approach but that it is considered better judgment and flying technique to be able to use a constant power setting and use additional flaps as needed to complete a landing reasonable close to a pre-determined spot.

This landing system was set up as being best for the B-26 type airplane inasmuch as it allows a safety factor great enough so that a landing will be successfully completed, even if a complete engine failure is experienced after the approach is started.

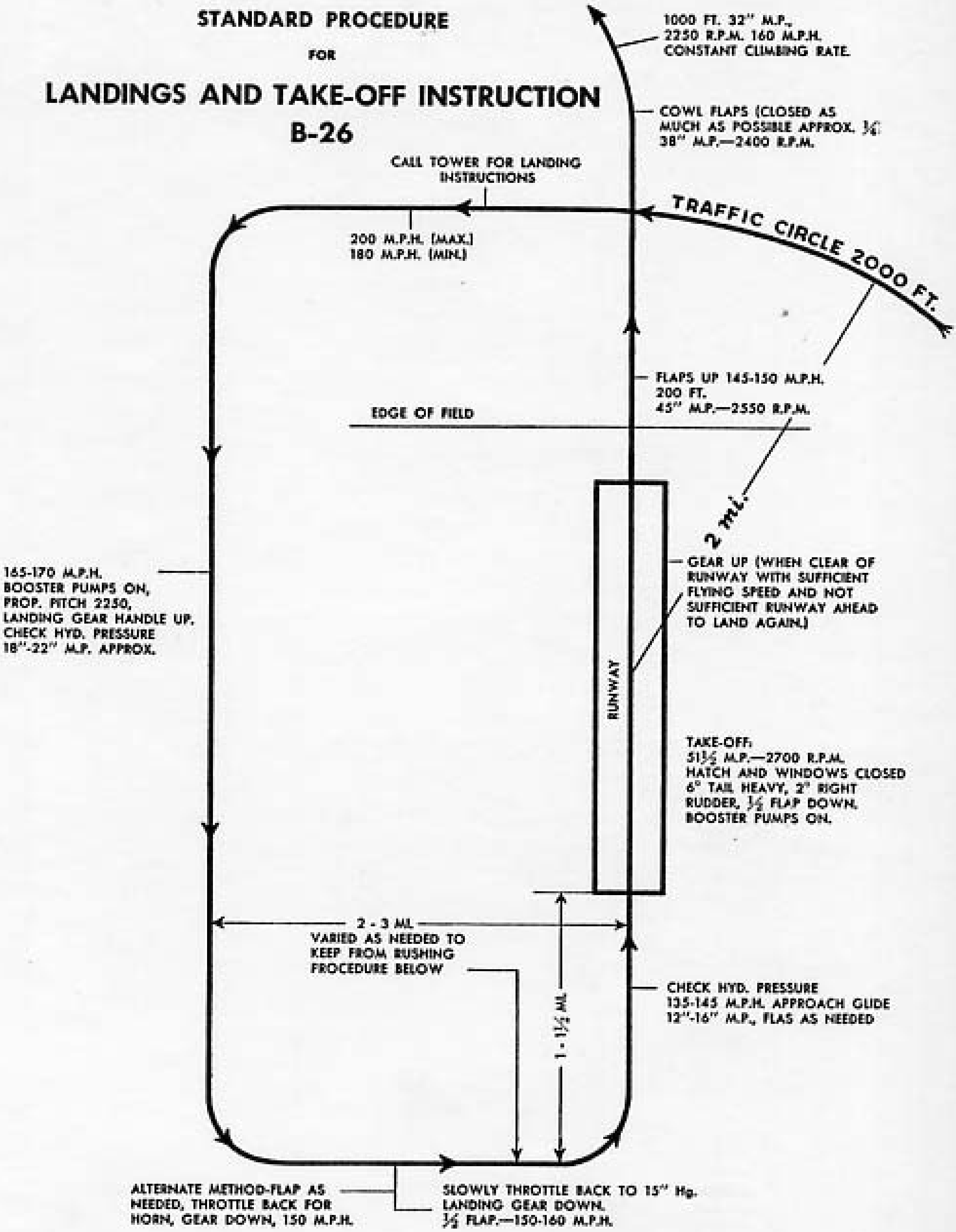
After the landing is made the nose-wheel should be held clear for a reasonable distance then lowered gently.

BRAKES SHOULD NEVER BE USED UNTIL THE NOSE-WHEEL MAKES CONTACT WITH THE GROUND.

## STANDARD PROCEDURE

FOR

# LANDINGS AND TAKE-OFF INSTRUCTION
# B-26



# PART III
# PILOT'S CHECK LIST

# STARTING AND WARM-UP

## CHECK FLIGHT CONTROLS AND TABS FOR FREE OPERATION AND PROPER TRAVEL

1. Parking Brakes "ON". Check Emergency Air Bottle Valve for "ON" and Pressure Normal (1000#).
2. Check all Hatches, Covers, Bomb-bay Doors, Camera Doors and Engine Cowling for security.
3. Turn ON Battery, Master and Propeller Safety Switches.
4. Feather Propellers—using DECREASE RPM Switch.
5. Partially un-feather Propellers with INCREASE RPM Switch; then with Switch in FIXED PITCH position, check for short circuits by slight movements of Toggle Switch in all directions. Continue un-feathering Propellers by use of INCREASE RPM Switch until high RPM position is reached and repeat check for short circuits.
6. Place Propeller Toggle Switches to AUTOMATIC and Propeller Governor Controls full forward to low pitch (HIGH RPM). NOTE: Engines will be started and stopped in this position.
7. Engines in LOW BLOWER (always start and take-off in low blower).
8. Carburetor Heat Control to COLD.
9. Turn on Generator Switches and Engine Switch (Engine to be started).
10. Mixture Controls in "IDLE CUT OFF".
11. Turn on Booster Pump Switch (Engine to be started).
12. Start Engine—using primer as necessary. As soon as Engine starts, move Mixture Control smartly to Automatic Rich. Warm up Engines at 1000 RPM.
13. Booster Pump Switch "OFF", after Fuel Pressure is normal.
14. Check Hydraulic Pumps on each Engine 750# min. and 950#–1050# max.
15. Check operation of Cowl Flaps, Oil Cooler Shutters and Wing Flaps.
    NOTE: Cowl Flaps and Oil Cooler Shutters must be "OPEN" during warm-up and take-off.
16. Return all Control Handles, painted white to "NEUTRAL" after operation—except Landing Gear Control on ground.

17. Release and re-set Parking Brakes.
18. After proper Engine Temperatures and Pressures have been reached—oil approximately 40° and 80#–90#, Cylinder Head Temperature minimum of 100°, check propeller operation at 25" HG Manifold Pressure by:
    (1) Decrease RPM to 1500, using DECREASE RPM Switch, then return to original RPM by using INCREASE RPM Switch.
    (2) Place both Propeller Toggle Switches in AUTOMATIC.
    (3) Decrease RPM to 1500 RPM by Propeller Governor Control, then back to original RPM by same control.
19. Check Magnetos at 30" (RPM should be approximately 2000 to 2250) not to exceed 15 seconds.
20. Rapidly, but smoothly, increase Manifold Pressure to 49" (not to exceed 5–10 seconds) to check that governor does not exceed 2700 RPM.
21. Check Ignition Master Switch OFF momentarily at Idling RPM.
22. Check Voltage and Generator output with BOTH ENGINES at 1900 RPM. If the difference in Generator readings exceed 15 Amperes—investigate.
23. Check Radio.
24. All Flight Instruments UN-CAGED.
25. Immediately upon starting to Taxi, try Brakes for proper functioning.

## BEFORE TAKE-OFF

1. While Taxiing to take-off position, make a smart Taxi run until Airspeed indicates 50–60 MPH, checking for Nose Wheel Shimmy and for proper Brake functioning.
2. CHECK FLIGHT CONTROLS FOR FREE MOVEMENT.
3. Blower ratio (LOW).
4. Carburetor Heat Control (COLD).
5. Cowl Flaps (OPEN).
6. Oil Cooler Flaps (OPEN).
7. Mixture Controls (AUTOMATIC RICH).
8. Propeller Safety Switches (ON).
   Propeller Toggle Switches (AUTOMATIC).
   Propeller Governor Controls FULL FORWARD HIGH RPM.

9. Set Throttle and Propeller Locks for proper friction.

10. Set Aileron to NEUTRAL.

11. Apply 2° to 3° right rudder tab.

12. Apply 5° TAIL HEAVY Elevator Tab (if lightly loaded).

13. Lower Wing Flaps as desired (Normal ¼ to ½).

14. Check Gasoline Gauges.

15. Booster Pumps "ON".
NOTE: Turn "OFF" after Take-off as soon as practicable.

16. Run engines up momentarily at approximately 40″ HG and 2500 RPM.

17. Reduce to 30″ HG and check Magnetos.

18. Remove Safety Lock from Landing Gear Handle.

19. Maximums for TAKE-OFF.

| | | |
|---|---|---|
| Manifold Pressure | 51.5″ HG | Propeller Governors 2700 RPM. |
| Cylinder Head Temp. | 218°C Max. | 120° C Min. |
| Oil Temperature | 95°C Max. | 40° C Min. |
| Oil Pressure | 90# Max. | 60# Min. |
| Fuel Pressure | 15# to 17# | |
| Hydraulic Pressure | 850# to 1050# | |

20. Retract Landing Gear as soon as practicable after Take-off.

21. Retract Wing Flaps as soon as practicable. (Should have at least 140 MPH).

22. Obtain 150 MPH as soon as possible.

23. Reduce Manifold Pressure and RPM to approximately 38″ and 2400 RPM as soon as practicable.
NOTE: Full Military Power of 51.5″ and 2700 RPM is allowed for five minutes, but is not good practice unless absolutely needed.

24. Set cowl flaps as dictated by Cylinder Head Temperatures.

25. Set Oil Coolers as dictated by Oil Temperatures.
NOTE: Keep Oil Cooler Shutters closed or nearly closed in outside Air Temperatures 0°C or less. With Shutters open, oil is congealed, sometimes causing a severe rise in oil temperatures, bringing about the unusual procedure of having to close shutters to reduce temperatures.

## BEFORE LANDING

1. Automatic Flight Control ("OFF").
2. Mixture (Automatic Rich).
3. Carburetor Heat Control (As dictated by atmospheric conditions).
4. Check for sufficient fuel in Main Tanks.
5. Reduce Speed to 150 MPH. Lower Landing Gear.
6. Check Gear Warning Indicator that Gear is down and locked.
7. CHECK HYDRAULIC PRESSURE–Normal 850 to 1050.
8. Lower Wing Flaps as desired.
9. Propeller Toggle Switches in Automatic (RPM 2200 to 2300).

## AFTER LANDING

1. Landing Gear Handle Safety Lock "ON". (It is recommended that this be done only after airplane has come to complete stop.)
2. Cowl Flaps and Oil Coolers (OPEN).
3. Wing Flaps (UP).
4. Propeller Governor Controls FULL FORWARD (HIGH RPM).
5. TAXI in.
6. Parking Brakes (ON).
7. Run Engines few seconds at 1000 RPM. Mixture Controls to IDLE CUT OFF. All switches "OFF" as soon as propellers have stopped.

# PART IV

# ALLOWABLE LIMITS AND TOLERANCES FOR PRODUCTION FLIGHT TESTS ON THE MARTIN B-26

# ALLOWABLE LIMITS AND TOLERANCES FOR PRODUCTION FLIGHT TESTS ON THE MARTIN B-26



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This information is not intended as a manual but only as a guide in properly completing the "Flight Check List".

THE GLENN L. MARTIN COMPANY

# TEST FLIGHT SECTION

## FLIGHT CHECK LIST MODEL B-26

—1—

| | | |
|---|---|---|
| Model | Lv. Apron | Date |
| Chalk No. | Take-off | No. Landings |
| Mfgr's. No. | Landing | C. G. Location & M. A. C. |
| A. C. No. | Arr. Apron | Gross Wt. |
| Flight No. | Operating Time | Loading No. |

Sec. 1 PILOT INSTRUMENT READINGS

| | S | U | LEFT | S | U | RIGHT |
|---|---|---|---|---|---|---|
| Rated Take-Off H. P. | | | | | | |
| Tachometer | | | | | | |
| Manifold Pressure (in. Hg) | | | | | | |
| Mixture Setting | | | | | | |
| Blower Ratio | | | | | | |
| Cowl Flap Setting | | | | | | |
| Oil Cooler Shutter Setting | | | | | | |
| Fuel Pressure (p. s. i.) | | | | | | |
| Oil Pressure (p. s. i.) | | | | | | |
| Oil Temperature (°C) | | | | | | |
| Cylinder Head Temperature (°C) | | | | | | |
| Carburetor Air Temperature (°C) | | | | | | |
| Vacuum (in. Hg) | | | | | | |
| Free Air Temperature (°C) | | | | | | |
| Air Speed (Static Pres.) | | | | | | |
| Air Speed (Alternate Source) | | | | | | |
| Altitude | | | | | | |
| Hydraulic Pressure | | | | | | |

Sec. 2 PEDESTAL CHECK

| | LEFT S | LEFT U | RIGHT S | RIGHT U |
|---|---|---|---|---|
| Throttle Controls | | | | |
| Prop. Governor Controls | | | | |
| Prop. Switches | | | | |
| Mixture Controls | | | | |
| Magnetos | | | | |
| Cowl Flaps | | | | |
| Oil Cooler Shutters | | | | |
| Supercharger Clutch | | | | |
| Heating System | | | | |
| Heating System | | | | |
| Defroster System | | | | |

Sec. 3 PILOT INSTRUMENTS

| | S | U |
|---|---|---|
| Gear Pos. Indicator | | |
| W. F. Indicator | | |
| C. F. Indicator | | |
| O. C. S. Indicator | | |
| Directional Gyro | | |
| Gyro Horizon | | |
| Magnetic Compass | | |
| Fuel Warning Test Switch | | |
| Turn and Bank | | |
| Rate of Climb | | |
| Clock | | |

Sec. 4 FLIGHT CONTROLS

| | DEGS. | S | U |
|---|---|---|---|
| Rudder Tab | | | |
| Elev. Tab | | | |
| Aileron Tab | | | |
| Ailerons | | | |
| Elevators | | | |
| Rudder | | | |
| Wing Flaps | | | |

Sec. 5 LANDING GEAR

| | LEFT | RIGHT | S | U |
|---|---|---|---|---|
| Doors | | | | |
| Foot Brakes | | | | |
| Parking Brake | | | | |
| Nosewheel Castering | | | | |
| Nosewheel Centering Lock | | | | |
| Extension Time | | | | |
| Retraction Time | | | | |

Form 1070A

THE GLENN L. MARTIN COMPANY

# TEST FLIGHT SECTION

## FLIGHT CHECK LIST MODEL B-26



| Sec. 6 BOMBARDIER'S STATION | S | U | Sec. 7 NAVIGATOR'S STATION | S | U |
|---|---|---|---|---|---|
| Airspeed | | | Airspeed | | |
| Altimeter | | | Altimeter | | |
| Outside Air Temp. Gauge | | | Outside Air Temp. Gauge | | |
| Heating System | | | Instrument Lights | | |
| Windshield Defroster | | | Navigator's Turret | | |

| Sec. 8 RADIO OPERATOR'S STATION | S | U | | S | U |
|---|---|---|---|---|---|
| Interphone System | | | Radio Compass Reception | | |
| Command Receiver Reception | | | Radio Compass Loop | | |
| Command Transmitter | | | Radio Compass D. F. | | |
| Liaison Receiver Reception | | | Instrument Lights | | |
| Liaison Transmitter | | | Generator Controls | | |

| Sec. 9 GENERATOR READINGS | S | U | LEFT ONLY | S | U | RIGHT ONLY | BOTH GENERATORS ON S | U | LEFT ONLY | S | U | RIGHT ONLY |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| AMPERES | | | | | | | | | | | | |
| VOLTS | | | | | | | | | | | | |

| Sec. 10 FLIGHT CHARACTERISTICS | SPEED | S | U | Sec. 11 MISCELLANEOUS ITEMS | S | U |
|---|---|---|---|---|---|---|
| Maximum Speed | | | | Bomb-door operations | | |
| Stalling Speed--clean p. o. | | | | Windows | | |
| Stall Characteristics | | | | Hatches | | |
| Single Engine Performance | | | | Pilots' Seats | | |

| Sec. 12 WINTERIZATION EQUIPMENT | S | U | | S | U |
|---|---|---|---|---|---|
| Carburetor Anti-Icer | | | Wing De-Icer Control | | |
| Prop. Anti-Icer | | | Windshield Wiper Operation | | |

COMMENTS:

Signed ____________________
Pilot

Signed ____________________
Co-Pilot

Signed ____________________
Flight Engineer

Form 1071A

## SECTION 1

## PILOT INSTRUMENT READINGS

1. Rated Take-Off H. P.

   On R-2800-43 engines 2000 H.P. is obtainable with 2700 R.P.M. at 51.75″ Hg. at sea level. Maximum R.P.M. on blocks will probably not be over 2650 on –43 engines.

2. Tachometer.

   Allowable fluctuation above 1600 R.P.M. + or – 30, allowable fluctuation between 1200 R.P.M. and 1600 R.P.M. + or – 50. Tachometers should not vary over 50 R.P.M. at synchronization.

3. Manifold Pressure.

   No fluctuation in either high or low blower.

4. Mixture Setting.

   Check in all positions (except idle cut-off in flight) with propellors in fixed pitch for variation of R.P.M., allowable + or – 75 R.P.M.

5. Blower Ratio.

   No change in manifold pressure after once set at constant altitude and R.P.M. DO NOT USE HIGH BLOWER AT LESS THAN 9500 FEET.

6. Cowl Flap Setting.

   When the cowl flap is faired, i.e., trail position, the indication should be 0°. The full closed position should be indicated by some small negative value (approximately–5°) on non-winterized airplanes and 0° on winterized airplanes.

7. Oil Cooler Shutter Setting.

   When the oil cooler shutter is faired the indication should be 0°. On winterized airplanes 0° will also indicate full closed, on non-winterized airplanes full closed will be indicated by a slight negative value (approximately –5°).

8. Fuel Pressure.

   There shall be no fluctuation of fuel pressure and never should exceed 17 p.s.i., with booster pumps on. The minimum value shall not be lower than 15 p.s.i. inch, desired 16 p.s.i.

9. Oil Pressure.

Oil pressure shall not be below 40 p.s.i. at 1000 R.P.M. and shall not exceed 90 p.s.i. at 60°C at 2000 R.P.M. The minimum operating pressure shall not be less than 75 p.s.i. or more than 90 p.s.i. desired 80 p.s.i. Remember, oil pressure drops somewhat with an increase of oil temperature.

10. Oil Temperature.

The oil temperature operating limits are: Minimum 60°C, maximum 90°C, desired 70°C. There shall not be more than 10% + or — deviation between the two engines with the same cowl and oil cooler flap settings.

11. Cylinder Head Temperature.

Cylinder head operating temperatures shall be at cruising—minimum 150°C, maximum 210°C, desired 180°C. There should not be over 10% variation in head temperatures with the same cowl flap settings. Keep even head temperatures while operating by the use of the cowl flaps.

12. Carburetor Air Temperature.

The thermometer bulb is located in the elbow of the carburetor air duct and serves to indicate temperature of the carburetor air. There should not be over + or — 10° variation in the reading of both instruments.

13. Vacuum.

The safe operating limits of both engine driven vacuum pumps are: Minimum 4 lbs., maximum 5 lbs., desired 4.5 lbs. There should not be over 15% + or — difference between the two indications.

14. Free Air Temperature.

To the pilot's discretion as to the use of carburetor heat and oil cooler shutters. Desired power setting of 27″ Hg. at 2100 R.P.M. when taking all flight check list readings. Remember that the point at which this type of P.D. carburetor will most readily ice up is from + 1°C to + 14°C.

15. & 16. Air Speed.

Air speed reading shall not vary more than 1% between the static and alternate source of supply, allowing time for stabilizing.

17. Altitude.

To the pilot's discretion, however, altitude should be kept constant as should the air speed during the time all readings are being taken.

18. Hydraulic Pressure.

The regulating valve should cut in at 900 p.s.i., with a tolerance of $+0-50$, and to cut out at 1000 p.s.i., with a tolerance of $+50-0$. Check hydraulic pressure for drop with all controls in neutral.

## SECTION 2

## PEDESTAL CHECK

1. THROTTLE CONTROLS.

   There should not be more than 1/4" difference between the throttle knob settings at a constant manifold pressure and constant R.P.M. Also, there shall be equal tension on the throttle and approximately equal pinch at idle position.

2. PROPELLER GOVERNOR CONTROL.

   There shall not be more than 1/4" difference between the two knob setting with both engines synchronized. Also, check the tension and full travel. Full high R.P.M. on the R-2800-43 series shall be 2700 + or — 25 R.P.M. Governor sluggishness should be checked by placing the ship in a fairly steep climb at cruising power until 150 I.A.S. is reached then placed in a dive until 200 I.A.S. is reached, governors should remain within 25 R.P.M. of each other.

3. MIXTURE CONTROLS.

   See that the mixture controls line up with the correct markings on the plate. Check the proper operation in each position (except idle cut-off while in flight) and that the controls seat firmly in each position.

4. MAGNETOS.

   Check each magneto on both engines at 30" Hg., with the propellers in fixed pitch. Maximum allowable drop 75 R.P.M.

5. COWL FLAPS.

   Ascertain that the control lever seats in each of the three positions and operates smoothly. Check flaps for creep in flight. Time of operation shall be 4 seconds minimum, 7 seconds maximum, desired 6 seconds.

6. OIL COOLER SHUTTERS.

   Check the control operations as per instructions in No. 5, Cowl Flaps, also check for creep in flight. Time of operation shall be 4 seconds minimum, 7 seconds maximum, desired time 6 seconds.

7. SUPERCHARGER CLUTCH.

   Check for proper setting in both low and high blower positions and for smooth operations, also check for excessive amounts of change in manifold pressure. DO NOT USE HIGH BLOWER AT LESS THAN 9500′. Do not change rapidly from one blower setting to the other and back again to the original. Whenever a change has been made, leave the blower in the new setting for at least five minutes. Make all blower changes at 20″ Hg. and not to exceed cruising R.P.M.

8. Heating System.

A check of the heating system shall be made in flight to ascertain if it is hooked up properly and is not leaking.

9. Defrosting System.

The defrosters should be checked for satisfactory operation when the check on item No. 8—Heating System—is made. In weather conditions where no frost exists the flight crew should be sure that a good blast of warm air comes out of the small holes on the top side of the distributing tube and that the small butterfly valves in said tube operate correctly.

# SECTION 3

# PILOT INSTRUMENTS

1. Gear Position Indicator.

The landing gear position indicator shall indicate the true position of the gear at all times. There shall not be any noticeable lag in time between the actual gear position and the indication of same on the instrument panel.

2. Wing Flap Position Indicator.

The wing flap position indicator shall indicate simultaneously with the wing flap position.

3. Cowl Flap Position Indicator.

The cowl flap position indicator shall indicate the true position of the cowl flaps at all times.

4. Oil Cooler Shutter Position Indicator.

The oil cooler shutter position indicator shall indicate correctly and simultaneously with the oil cooler shutter.

5. Directional Gyro.

Check for excessive precession, maximum 5° per 15 minutes. Gyro should not spill in 60° banks. In a 360° turn + or —20% error is the maximum allowable tolerance.

6. Magnetic Compass.

Check to see that the compass has sufficient fluid, no leaks and proper dampening.

7. Turn and Bank.

Check for operation at a constant altitude and airspeed for two minutes each way using the gyro-horizon to check the degree of bank. One needle width on the T. and B. and 25°–30° at 200 M.P.H. Bank should give a 360° turn in two minutes. Tolerances + or — 10 seconds, or 30°.

8. Rate of Climb.

Indication should be zero on the ground and in level flight. Check ascent and descent time for 1000 feet per minute by the use of the altimeter and clock.

9. Clock.

Set the clock with the tower prior to take-off and check again upon completion of the mission.

# SECTION 4
# FLIGHT CONTROLS

1. Rudder Tabs.

The allowable rudder trim necessary to maintain straight flight at cruising speed shall be not more than 2° R. or L. This value shall not increase with increased speed.

2. Elevator Tab.

The maximum allowable elevator trim tab necessary to maintain level flight shall not exceed 4°, nose heavy or 1° tail heavy.

3. Aileron Tab.

The maximum allowable aileron trim shall not exceed 5° R. or L. at cruising speed. This value shall not increase with an increase in speed.

4. Ailerons.

The ailerons shall have full and free travel throughout their entire operating range. The control wheel shall be centered (top spokes level) when the aircraft is trimmed for level flight, tolerance + or — 10°.

5. Elevators.

The elevators shall operate smoothly and have full travel.

6. Rudder.

The rudder shall have full travel; its operation shall be smooth and no tendency to buffett in flight.

7. Wing Flaps.

The aircraft shall have no tendency to roll when the flaps are operated and there shall be no creeping in any position. Operating time shall be minimum 15 seconds, maximum 20 seconds, desired 16 seconds at 160 M.P.H. If flaps creep up with control handle in "Neutral", the ship should be reflown at least 30 minutes.

# SECTION 5
## LANDING GEAR

1. Main Gear Doors.

Main gear doors will be checked for sag and if ½″ or more the ship should be reflown.

2. Foot Brakes.

Check for smooth operation and equal application compared to the amount of travel on the pedal. Check position of pedals with regard to brake tension. The foot brakes shall hold 52″ Hg. on either engine.

3. Parking Brake.

The parking brake shall hold 40″ Hg. on both engines.

4. Nosewheel Castering.

Check for smooth operation and no binding when the aircraft is being turned.

5. Nosewheel Centering Lock.

Check the nosewheel for centering when the gear is in the down position in the air (suggest this be done while the gear is being checked in flight prior to first landing.)

6. Extension Time.

The landing gear extension time at I.A.S. of 160 M.P.H., shall be: 12 seconds minimum, 18 seconds maximum, desired 14 seconds.

7. Retraction Time.

The retraction time of the landing gear shall be: Maximum 28 seconds, I.A.S. of 160.

# SECTION 6
## BOMBARDIER'S STATION

1. Airspeed.

   The bombardier's airspeed shall be accurate with the pilot's airspeed within + or — 3 M.P.H. at cruising speed.

2. Altimeter.

   The altimeter at the bombardier's station shall be accurate to + or — 100 feet at 10,000 feet when compared with the pilot's instrument.

3. Outside Air Temperature Gauge.

   The bombardier's outside air temperature gauge shall be accurate to + or — 5°C when compared with the pilot's gauge.

4. Heating System.

   The bombardier's heater is a hinged damper type located on the right side of the fuselage. It shall be determined that a good blast of warm air is emitted from this heater while in flight with the hot air valve in the navigator's compartment "ON".

5. Windshield Defroster.

   The bombardier's windshield defroster is a tube type entering from the right hand side of the fuselage and extending to approxiately the center of the Plexiglass nose section. It shall be determined that a sufficient blast of warm air comes from the end of this tube when the hot air valve in the navigator's compartment is "ON".

# SECTION 7

## NAVIGATOR'S STATION

1. AIRSPEED.

   The airspeed in the navigator's compartment shall be accurate with the pilot's airspeed to within + or — 3 M.P.H.

2. ALTIMETER.

   The navigator's altimeter shall be accurate to + or — 100 feet at 10,000 feet as compared to the pilot's altimeter.

3. OUTSIDE AIR TEMPERATURE GAUGE.

   There shall not be more than + or — 5°C. difference between the navigator's and pilot's outside air temperature gauge.

4. NAVIGATOR'S TURRET (Escape Hatch).

   See that the navigator's hatch is in place and properly secured. Extreme caution should be used in putting the Plexiglass dome in place during flight. The airspeed should not exceed 165 M.P.H. indicated while the dome is being placed.

# SECTION 8
## RADIO OPERATOR'S STATION

1. Interphone System.
The radio operator's interphone shall be checked for proper operation at the same time as the Liaison receiver. Check in "call" position as well as "Inter".

2. Command Receiver Reception.
It shall be determined that each of the three command receivers work properly both when operated singly and in conjunction with each other.

3. Command Transmitters.
Both command transmitters shall work in flight, number 1 transmitter shall be set on 5417.5 KC. Number 2, 3 and 4 positions on the pilot's band switch are interphone positions and it shall be determined that these positions function in a satisfactory manner.

4. Liaison Receiver Reception.
The liaison receiver shall be checked for satisfactory operations on ALL bands in flight.

5. Radio Compass Reception.
Reception on each of the three bands of the compass receiver will be checked on Loop, Antenna and Compass.

6. Radio Compass Loop.
When the compass receiver is in the loop position the two-speed loop switch shall be checked for high and low speed rotation of the loop antenna.

7. Radio Compass D.F.
The radio receiver shall be checked on all three bands for homing and direction finding. It is suggested that Station WBAL, 1090 KC, be used for homing. The following stations are suggested for direction finding:—

| | *Freq. in KC* | *Call* | *Location* | *Bearing from Field* |
|---|---|---|---|---|
| North | 710 | WOR | Newark, N. J. | 62° |
| South | 332 | WA | Washington Radio | 232° |

10. Generator Controls.
The maximum allowable spread between generator ammeter readings shall not exceed 15 amperes or a difference in voltage of not more than 0.5 volts.

# SECTION 9

# GENERATOR READING

1. GENERATOR READINGS.

   It is recommended that the generator never be shut off in flight when the ammeter reading is 150 Amps. or more.

2. VOLTAGE READINGS.

   For voltage readings, both switches should be turned off and readings taken at no load.

# SECTION 10
# FLIGHT CHARACTERISTICS

1. Maximum Speed.

There shall be no unusual or excessive vibration, buffeting or cam action of controls at any speeds above cruising and not exceeding the red line.

2. Stalling Speed, Clean, Power Off.

There shall be no unusual or violent characteristics when the aircraft is stalled clean and without power. It will be found that the average stall speed is 112 + or — 3 M.P.H.

3. Stall Characteristics.

Any unusual stall characteristics will be written as an item and further flights will be necessary.

# SECTION 11

## MISCELLANEOUS ITEMS

1. **Bomb-Door Operation.**

The bomb-doors shall be checked in flight for satisfactory operation and time. The time on the front doors only shall be: maximum 35 seconds, desired 28 seconds. Rear doors only: maximum 20 seconds, desired 14 seconds. Both sets of doors simultaneously: maximum 30 seconds, desired 24 seconds.

2. **Windows.**

It shall be determined that all windows and window fasteners operate in a safe and satisfactory manner prior to flight. The pilot's and co-pilot's sun visor shall be adjusted properly and safely.

3. **Hatches.**

All hatches shall be securely fastened prior to take-off and it shall be determined that the safety clip on the pilot's escape hatch is of the proper type and has sufficient tension.

4. **Pilots' Seats.**

All adjustments of the Pilot's and Co-Pilot's seats shall work in a satisfactory manner, including safety belts, floor tract, etc.

# SECTION 12

# WINTERIZATION EQUIPMENT

1. Wing De-Icer Control (Reflight).

   The control for the wing de-icers is located at the left of the generator control box and is of the locked lever type. The de-icer gauge is located in the lower right side of the pilot's instrument panel. The normal operating pressure is 7.5 lbs/sq. inch, minimum 6.0 lbs/sq. inch, maximum 10.0 lbs/sq. inch. The normal operating time per cycle is 40 seconds, tolerance + or — 5 seconds. At speeds up to 250 M.P.H. there should be no ballooning or rippling with the de-icer system off.

2. Windshield Wiper Operation.

   The windshield wiper is of the two speed type, the control (circuit breaker and "fast-slow-off" switch) is located on the pilot's instrument panel. DO NOT OPERATE ON A DRY WINDSHIELD.

# SECTION 13

## PILOT'S RESPONSIBILITY

All items not covered by this directive will be left to the discretion of the pilot as to whether action and/or reflight is necessary.

# PART V
# EMERGENCY INSTRUCTIONS

## *Emergency Instructions*
## *Model B-26, B-26A, B-26B, B-26C Airplanes*

### April 11, 1942

The instructions given on the following pages are those which have been followed on previous occasions and may therefore be considered as the best procedure available under the noted conditions. However, unforeseen conditions may arise which have not previously been experienced. It is therefore essential that each pilot and crew member thoroughly familiarize himself with the airplane and its operating systems in order to satisfactorily accomplish intended missions.

## ELECTRICAL SYSTEM EMERGENCIES

(A) In the event that a complete failure of the electrical system is imminent; i.e., both generators have ceased to function and this fact has not been noted in time to save the remaining energy in the batteries; usually there will be an indication of the coming failure by oscillation of the Landing Gear and Flap indicator and/or oscillation of the Autosyn Instruments:

1. Place Propeller Toggle Switches in FIXED PITCH.
2. IMMEDIATELY turn off both Generator Switches (This is important).
3. IMMEDIATELY turn off both Battery Switches.

NOTE: Even though Propeller Toggle Switch remains in AUTOMATIC, propellers automatically fix when electrical current is cut, but place Propeller Toggle Switch in FIXED PITCH position to prevent surge when batteries are turned back on. Remember that any change in air speed immediately changes the R.P.M. For instance, if cruising speed was 200 I.A.S., R.P.M. 2000, manifold pressure 25", and altitude 5000 feet at time electrical current is lost, or you place propellers in fixed pitch, your R.P.M. will remain the same as long as you accurately hold your altitude and Air Speed. If you allow nose to drop and your air speed increases to 220 M.P.H. you may get an increase of from 200 to 400 R.P.M. Conversely, if you allow Airplane to climb, your R.P.M. will immediately decrease. This entirely normal re-action of Propellers in a fixed pitch condition, sometimes in moments of stress, causes pilots to believe that Propellers are "running away" or conversely "trying to feather". Naturally changes in throttle settings will also affect your R.P.M.; for you are now flying a Fixed Pitch Propeller Type Airplane.

After 15 to 30 minutes flying, your batteries should rebuild sufficient energy to allow you approximately five (5) minutes; (this is an estimate only), to set your propellers to desired R.P.M. by use of INCREASE and/or DECREASE R.P.M. Switches.

4. For landing purposes in FIXED PITCH, it has been found by experimenting that a good optimum setting is approximately 2200 R.P.M., with 25" manifold pressure at 150 M.P.H. This will give you plenty of power if needed, to drag in the field or go around again.

(B) The next condition of an electrical emergency to be considered is the discovery that both Generators have failed but that the Batteries are not completely discharged. In this condition, it is estimated from the known capacities of the Batteries that you have at least thirty minutes of full operation. In this case, if you are still several hours from a landing, follow the same procedure:

1. Set Power and R.P.M. to Desired Cruising.
2. Place Propeller Toggle Switches to FIXED PITCH.
3. Turn off both Generator Switches.
4. Turn off both Battery Switches.

Now, with a known reserve of electrical energy in batteries, it is possible to turn on Battery Switches every ten or fifteen minutes, to check Engine Instruments, etc., reserving sufficient energy to make a normal landing at destination with Propeller Toggle Switches in AUTOMATIC. If in any doubt of sufficient current when preparing to land, follow procedure of setting propellers, etc. as outlined in (A-4) above.

# PROPELLER EMERGENCIES

## PROPELLER GOVERNORS

Case I.

On some take-offs, especially where Throttles are "Jammed" ON too suddenly to allowable rated power of 49", one or both engines may over-rev momentarily causing a howling sound. This is entirely normal and governors usually control the R.P.M. back to 2600 or 2650 RPM. If, however, as acceleration of airplane increases, and the R.P.M. goes above the allowable without instantly coming back:

1. Cut Throttles—discontinuing take-off.
   NOTE: On most fields this can be done with absolutely no danger even after reaching take-off speeds of from 100 to 110 M.P.H.
2. Check to see if Propeller Safety Switches are ON and if Propeller Toggle Switches are in AUTOMATIC. If these are in proper settings—governor failure is indicated.
3. Have Governor setting checked.

In many cases where Propellers go to as high as 2700 to 2725 R.P.M. on take-off run, it is caused by Governor setting being a little high. An experienced pilot generally has time enough during take-off run to see if they hold at this R.P.M. and also to try his Propeller Governor Controls to see if they decrease the R.P.M., and hold it. In any case of doubt, however, cut throttles and discontinue take-off.

Case II.

If shortly after take-off a propeller Governor fails, allowing R.P.M. to increase rapidly, causing what is known erroneously as a "Run-Away" Propeller, the seriousness of this emergency depends mainly on the Air Speed, R.P.M. and Power at time of Governor failure.

If for instance governor failed at 120 M.P.H. with Landing Gear retracting or fully retracted with 48" HG Manifold Pressure and 2600 R.P.M. your Air Speed is naturally increasing, so R.P.M. starts increasingly rapidly. If Air Speed is held at 120 M.P.H., R.P.M. should remain nearly constant at 2600. However, the natural inclination and in fact, imperative one is to obtain a safer Air Speed, of at least 150 M.P.H. In doing this, R.P.M. will probably increase to 3000 R.P.M. or more. We are making this problem difficult by assuming that the DECREASE R.P.M. Switch and FEATHERING SWITCH are also Inoperative.

Naturally, if DECREASE R.P.M. Switch is working, the correction is relatively simple by allowing Air Speed to increase where desired and holding R.P.M. within safe limits by means of the DECREASE R.P.M. Switch.

Continuing our problem, however, from the point 120 M.P.H., 48″ and 2600 R.P.M. and the propeller starts "Running Away", the following procedure will be accomplished very rapidly.

1. Leave good Engine alone but be prepared for YAW toward "Run Away" Engine.
2. Pull back Propeller Governor Control Handles, if R.P.M. does not decrease immediately.
3. Hold Propeller Toggle Switch to DECREASE R.P.M., and if R.P.M. does not decrease immediately.
4. Release Propeller Toggle Switch to FIXED PITCH POSITION.
5. Reduce Manifold Pressure on "Run Away" Engine to hold R.P.M. at a maximum of 3000.
6. *WATCH FOR YAW—DON'T FORGET TO FLY AIRPLANE.* Until safe Air Speed and Altitude is reached, this is of more importance than anything else! It may be necessary at this point to reduce power and R.P.M. on good Engine to keep Airplane under control. Use Trim Tabs to obtain best flying conditions to hold 150 M.P.H. in level flight. As you drop nose, power must be reduced to keep from increasing Air Speed (which in turn will cause fixed Propeller to increase R.P.M.). Keep good Engine slightly down and make all turns (gentle only) toward it. Return toward landing position.

It should be possible now by experimenting to find the best setting for the "Run-Away" Engine. Reduce Manifold Pressure to reduce R.P.M. as low as possible, holding Air Speed constant but do not reduce Manifold Pressure below 15″ until ready to land. Use extreme caution in making approach, being especially careful not to undershoot. Try to make your landing a good 400′ to 500′ inside field, remembering that this airplane can be brought to a stop in a very short distance.

CASE III.

From the above procedure it can be seen that a Propeller Governor failure while at cruising speeds and altitudes is a relatively simple problem, even should both Propeller Governors fail simultaneously.

By all laws of averages, this is an extremely remote possibility, except in the case of a partial or complete electrical power failure, which is not truly a governor failure but would cause propellers to fail to respond to governors.

Propeller setting and Landing Procedure is fully covered under the heading of ELECTRICAL SYSTEM EMERGENCIES.

## HYDRAULIC EMERGENCIES

These can be evidenced in several ways such as: (a) failure of landing gear to retract fully after take-off, (b) pressure gauge reading below normal, or (c) pressure gauge reading "o".

CASE I. *B-26, B-26A, B-26B, B-26C Airplanes.*

Hydraulic pressure normal before take-off, but Landing Gear fails to retract after take-off. This generally indicates an air lock around Hydraulic Pumps, but may be a more serious condition, so if possible follow this procedure:

1. Return Landing Gear Handle to "DOWN" position.
2. Pump Landing Gear down and locked with Hydraulic Hand Pump (on Right Side of Pedestal).
3. Pump Flaps down as desired.
4. All White Handles to "NEUTRAL". (Important)
5. Check Landing Gear Indicator that Gear is down and locked.
6. Depress Brakes; pump up pressure to approximately 1200#. Release and repeat several times.
7. Land, with Brakes *slightly* depressed (*WARNING: Do not land with brakes locked.*) and co-pilot steadily pumping Hand Pump. Do not fully release Brake Pedals at any time during glide and landing run, for this will release the pressure being built up on them by the Hand Pump. With this procedure, it should be possible to make a normal braking stop. If not, use Emergency Air Brake Handle (on Center Stringer above and to the right of Pilot's head).
8. Have Hydraulic System checked for mal-functioning.

If air is present in system, "Bleeding" can be accomplished from cock-pit by the following procedure on ground:

*IMPORTANT*: CHECK FOR PROPER RESERVOIR LEVEL AND ACCUMULATOR AIR PRESSURE.

1. Both Engines idling.
2. All White Handles to "NEUTRAL"—except Landing Gear, which is down.
3. Slowly push Emergency Nose Gear Handle (Red) to full "DOWN" position.
4. Slowly pump Brake Pedals twenty to thirty times, fully depressing and releasing.

5. Place Emergency Nose Gear Handle (Red) to Full "UP" position.
6. Increase R.P.M. to 1000–1200.
7. Hydraulic Pressure should got to Normal—950–1050#.
8. If not, repeat above procedure and check.
9. If no Hydraulic Pressure results, the mal-functioning probably caused by other than air in system.

In the event that Hand Pump (as outlined in #2 above) fails to pump Landing Gear down, "Bleeding" procedure in air may be tried as follows:

1. Climb to safe altitude (2000′ to 4000′) and trim airplane for level flying.
2. Have member of crew check for leaks and that there is sufficient Hydraulic Fluid in Reservoir.
3. Reduce R.P.M. to 1600–1800, increasing power to comfortably hold altitude at approximately 150 M.P.H. Pilot must not forget to hold altitude and air speed while he is busy with "Bleeding" procedure. Straight flying with no turns, or turns of gentle bank only, recommended.
4. All White Painted Handles "NEUTRAL".
5. Emergency Nose Gear Handle (Painted Red) to Full "DOWN" position.
6. Slowly pump Brake Pedals, Full "DOWN" and release, 20 to 30 times.
7. Emergency Nose Gear Handle (Painted Red) Full "UP".
8. Check Hydraulic Pressure Gauge. If indication of pressure (100# to 300#) is shown immediately, wait one to three minutes. If pressure does not come up to normal, repeat above procedure. Usually, two to three operations will be successful and Hydraulic system will function normally thereafter.

If after two or three "Bleeding" operations, no Hydraulic Pressure can be obtained, it is recommended that the Emergency Gear procedure as outlined on Pedestal be used.

It must be stressed at this point, that "Bleeding" is useless if Hydraulic failure is caused by loss of Hydraulic Fluid, so it is necessary to check that sufficient fluid is available before starting "Bleeding" procedure.

CASE II. *Loss of Hydraulic Fluid (B-26 and B-26A Airplanes)*

There is a Stand Pipe in the Hydraulic Reservoir which, in case of leaks anywhere in the normal hydraulic system, retains enough fluid to lower Landing Gear by means of an Emergency Landing Gear System. This procedure is outlined on Pedestal and is as follows:

1. Main Landing Gear Handle (White) to "DOWN" position.
2. Emergency Nose Wheel Handle (Red) to "DOWN" position.
3. Pump hand pump until Nose Gear is down and locked.
4. Emergency Main Gear Handle (Red) to "DOWN" position.
5. Pump Hand Pump until Main Gear is down and locked.
   NOTE: One Main Gear usually will unlock and go to the down position first. Keep pumping Hand Pump and the other will go down and lock.
6. Return Emergency Main Gear Handle and Emergency Nose Wheel Handle (Red) to "UP" position.
7. Place Main Landing Gear Handle (White) to "NEUTRAL".
8. With Flap Handle "DOWN", pump Flaps down and return Handle to "NEUTRAL". If there is insufficient pressure remaining to pump Flaps down, place Flap Control Handle (White) to "DOWN" position. (This is important). Member of crew may now crank flaps down mechanically, by means of crank on Rear Bulkhead of Forward Bomb Bay.
9. Check Air Bottle forward of Navigator's Seat to see that Valve is open and pressure is normal (1000#).
10. If possible, use braking procedure outlined in #7, Case I, but landing can be made using Emergency Air Brake. Do not pull until you have used as much of your landing run to kill off speed, as is consistent with safety. This must always be a matter of the pilot's judgment, however. Remember that when the Air Brakes are pulled, the Brakes are locked fully on and exert powerful braking action, so if the speed can be decreased to 40 to 50 M.P.H. or less, tires, propeller tips, etc. may be saved from damage.

CASE III. *Loss of Hydraulic Fluid B-26B* (Where Emergency Tank Has Been Provided, Stand Pipe in Main Tank has Been Removed)

1. Same procedure as above, except place valve (which is located right of pilot pedestal) to "EMERGENCY" position and make certain that this valve is in extreme position for emergency.

In any case of hydraulic failures, where the "Bleeding" procedure is unsuccessful, resort to the Emergency Landing Gear procedure.

# LOAD AND FIRE VALVE EMERGENCIES

## *Nose Wheel Gear*

There have been one or two instances where the nose wheel doors have failed to open due to maladjustment of the cam that strikes the Load and Fire Valve. In the event this occurs use the following procedure.

First—it is necessary that the crew be familiar with the location of this valve, as it may be necessary to "feel" for it during this operation. One should practice on the ground in finding this valve and the proper placing of a coin, screw driver, landing gear safety lock or some other similar object, on top of the Load and Fire Valve plunger in order that the cam may strike it and completely fire the Load and Fire Valve when the landing gear handle is placed in a "DOWN" position. This valve is located out of sight, forward and slightly to the right of Bell Crank on upper end of rod to left nose wheel door and on forward side of Cross Member Casting. The valve lies parallel to this cross member with plunger facing towards left.

A. The procedure is as follows:

1. Place landing gear handle in "UP" position.
2. One of the crew, while standing in Navigator's Compartment, opens sliding hatches, resting body weight on left hand placed on cockpit floor.

   *CAUTION*: Do not rest weight on nose wheel which will be directly under you.
3. Reach right hand under and forward until valve is located, placing coin, or similar object, on TOP of plunger.
4. Holding coin in this position, call or signal pilot to immediately return landing gear handle to "DOWN" position.

B. In event the chain that operates the nose wheel door is broken the procedure on the preceding page will not work because the cam will not operate. In this case there is another procedure by which it is possible to obtain direct access to this valve.

1. Flying will be done from Co-pilot's position during this procedure.
2. Measure back five inches from bottom rear of brake control cover (this is the raised cover extending back from between Rudder Pedals on Pilot's side) and one inch over to the left

from inside edge of right hand track of Pilot's Sliding Seat. This point will be approximately over Load and Fire Valve.

3. Carefully *"gouge"* a small hole (3" to 4" square) through dural floor. Extreme caution must be used as engine control cables and hydraulic lines are under this point.

4. Plunger end of Load and Fire Valve will be exposed and can be pushed in with screw driver or other suitable means as follows:

   (a) Main Landing Gear Handle—"UP" position.

   (b) Press in Load and Fire Valve and hold; simultaneously placing Main Landing Gear Handle to "DOWN" position.

   (c) Hold Load and Fire Valve in until Nose Gear is "DOWN" and locked.

   (d) Check Landing Gear Indicator for Gear "DOWN" and locked.

In some rare cases, with hydraulic system normal but with improper adjustment of Load and Fire Valve, the nose wheel gear will not release. Either of above procedures may be followed, but use caution if the first or "coin" method is tried as the valve operating cam may come around and strike fingers while holding coin on top of plunger.

# NOSE GEAR UNLOCKED

There have been several cases where—Nose Wheel is down but lock pin does not insert (due to faulty alignment). This is indicated by warning horn when throttles are retarded and by position of Nose Gear Indicator Instrument. Successful landings have been accomplished with no damage, by the following procedure:

1. Move C. G. rearward (within allowable limits) by moving ballast or crew members rearward.
2. Co-pilot increase hydraulic pressure as high as possible by Hand Pump (Usually about 1200 lbs.).
3. Make normal Two-Point (Nose Up) Landing on Main Gear as close to end of runway as is consistent with safety. Co-pilot steadily pump hand pump during entire landing run and keep hydraulic pressure as high as possible (Hydraulic Pressure keeps Nose Gear from collapsing so this is important). Immediately after landing, lower nose wheel *gently* for a slight tap on run way, and raise again slightly, holding off as long as possible. (This probably will tap Lock Pin in place). Use as much of runway as possible without use of brakes, keeping control column all the way back. When necessary, apply brakes smoothly, avoiding sudden application.

   "IMPORTANT" When airplane has stopped, DO NOT MOVE AGAIN UNTIL NOSE GEAR LOCK PIN IS VISUALLY CHECKED. If the landing jolted it in place—proceed with normal Taxi-in to line. If Nose Gear still unlocked, lock by some mechanical means usualy easily accomplished.

   (a) Check hydraulic pressure for normal.

   (b) All White Painted Handles to NEUTRAL except Landing Gear.

   (c) Chock wheels or pull emergency air brake and Release Brakes. *(Important)*

   (d) Cut engines.

# ENGINE FAILURE AT TAKE-OFF

*a*. Probably the most serious emergency which can arise during take-off is failure of one or both engines. Action possible by the pilot in event of failure of both engines is very limited, therefore, this discussion will be restricted to recommended procedure in event of failure of one engine.

(1) If one engine should fail during the ground run of a take-off, the immediate result would be that the airplane would swerve. The Pilot should immediately cut the other engine and use the brakes as much as possible. It will be impossible, even with a light load, to continue the take-off with one engine.

(2) Sudden failure of one engine during the short interval immediately after leaving the ground and before reaching the minimum speed for flying on single engine will cause the airplane to become uncontrollable, and if this takes place, the pilot should cut the other engine and land straight ahead. It is not practical to state definitely the minimum speed for single engine flying as this is determined to a large extent by the pilot's capabilities, the gross weight of the airplane, the power available from the remaining engine and the position of the landing gear. The average pilot on the alert and reacting quickly will be able to continue take-off with a normal gross weight, the landing gear in the process of retracting, if the air speed at the time of engine failure is not less than approximately 135 M.P.H. The airplane speed should not be allowed to drop below the minimum of approximately 135 M.P.H. at any time during flight on one engine.

(3) The following actions on the part of the pilot, arranged in proper sequence, should enable him to accomplish the most possible in event of one engine failure.

(*a*) Immediately apply all the rudder possible into the running engine and at the same time bank the airplane with the running engine down until a reasonable straight course can be maintained.

(*b*) Retract the landing gear if it is not already retracted.

(*c*) Feather the propeller on the failing engine. This action should be deliberate as it would naturally be disastrous to make a mistake and feather the running engine. Also, there is always a bare possibility that the failing engine may pick up and start running again.

(*d*) Increase the power of the running engine to the fullest extent possible but do not greatly exceed rated take-off manifold pressure as this will lead to detonation with a consequent loss of power. Do not exceed rated manifold pressure at all if it is not necessary.

(*e*) Reduce rudder forces, which will be heavy, by use of the rudder trim tab, thereby enabling the flight to continue on a straight course with the wings nearly horizontal. Do not under any circumstances permit the running engine to get above the failing engine while flying at a slow speed. It is suggested that 200 M.P.H. be the minimum speed at which a turn is made into the failing engine while at low altitude.

(*f*) If the pilot is using 30° wing flap for take-off, it will be necessary to raise the flaps as soon as possible in order to decrease drag. This will be a difficult operation at low altitude and at slow speeds. In order to prevent loss of altitude when the flaps are raised, it will be necessary to counteract the loss of lift by immediately pulling the nose up. If conditions are critical, i.e., low altitude and slow speed, the flaps should be raised in several steps or increments in order to avoid large changes in either speed or altitude.

(*g*) The drag of the airplane may be further reduced, therefore increasing single engine performance, by closing the cowl flap and oil cooler shutter on the engine with the feathered propeller.

(4) When making a single engine landing it should be remembered that the airplane cannot maintain altitude on one engine with the landing gear extended. The rudder trim tab used for single engine flight should be at least partially reduced before landing to prevent high rudder forces when the one engine is throttled. It should also be pointed out that the pilot is in serious difficulty again if he completely overshoots the landing field while on one engine with the landing gear down. On such a landing, the pilot should under no circumstances permit the speed to fall below 135 M.P.H. until he is definitely sure of making the landing.

# PART VI
# COMMENTS CONCERNING B-26 AIRPLANE

# COMMENTS CONCERNING
# B-26 AIRPLANE

The following comments concerning the B-26 Airplane by Mr. T. L. Taylor, former Chief Production Test Pilot, are inserted for the guidance and information of new pilots employed by the Glenn L. Martin Company that are not familiar with the B-26 type airplane.

Although it is written for the express purposes of young Army pilots who are just beginning to fly multi-engine airplanes, much of the written advice given in these comments could well be adhered to by older pilots who may not have had as much experience as Mr. Taylor flying multi-engine aircraft.

O. E. Tibbs
*Chief Production Test Pilot*

# APPENDIX "A"

to

# Memorandum 50-7, III BOMBER COMMAND, 9 September 1942

## COMMENTS CONCERNING B-26 AIRPLANE

by

MR. T. L. TAYLOR,
*Chief Production Test Pilot,*
THE GLENN L. MARTIN AIRCRAFT COMPANY.

The following is written mainly for young pilots who are beginning their check-off on the B-26 type airplane. It is the result of the many questions asked me on a two-week stay at a training center and I shall try to answer them in the same, everyday language that pilots the world over use. Although this will deal principally with flight characteristics of the B-26, a good bit of what I, personally, consider good flying rules will be incorporated for you young pilots who are having to assimilate years of experience in a very short time. The writer does not pose as an expert, and many of the rules, or methods he considers good, may be questioned perhaps, by other pilots.

## GENERAL ADVICE

Learn as much about your airplane as you possibly can, especially from a standpoint of pre-flight inspection, to satisfy yourself that it is as nearly perfect as good maintenance can make it. You may say that this is a duty of the crew chief, and so it is, but there are many working parts on this and all modern combat airplanes, so the more members of the crew who are familiar with them, the better the check with each other that your ship, with you as the captain, is ready to go. By this I do not mean that you will be able to have a perfect ship every time you fly, but you at least know what is out of commission, or partly so, and can weigh the importance affecting flight safety. In other words, you know the limitations and try to stay within them. We all know that chances must be taken, even in peace time flying, and especially so in combat, but we must learn to "take chances safely" which, at the risk of sounding paradoxical, is just what I mean. Remember, you are no good to your country if you kill yourselves. You must live and learn to kill the other fellow.

The three important features to be sure of are (a) your engines (b) your control surfaces and (c) how much load and CG position. With these first in good shape, you can overcome most any other type of failure, such as hydraulic, etc. I do not mean by this to neglect all the other vital checks, but in my estimation, these are *the three* important ones.

As you walk up to your ship, get in the habit of taking a general, all-over look at it to see if everything seems to be normal. Ask yourself as you look it over: Pitot tube covers off? Engine cowling in place and secured? Any puddles under engines or any noticeable fluid leaking at any point? If so, investigate. As you walk around your ship, take a look at all control surfaces and tabs to be sure there no loose fittings, etc.; stick your head up in the aft section to check for loose items that might jam controls in any fairly violent maneuvers, and, for a mental check on ballast and load which might affect your CG position. Learn what your total weight and CG position is with a more or less basic-loaded airplane and then make a mental calculation what the affect of additional crew members, baggage, cargo, etc., will do. This will be discussed more fully later, but remember as your load becomes heavier, your stalling speed is higher, the general performance is lowered, stresses and forces become much higher and the stability or controllability becomes less as the CG position moves toward either the forward or aft limit. When you know these things; then you know the limits to observe on the maneuvers you can do safely—you know that your take-off distance is increased, you know to increase slightly your gliding speeds and, in general, to do all maneuvers smoothly and gently.

Question: How do I know when my engines are putting out proper power?

Answer: With airplane on the blocks and approximately headed into the wind, it takes a certain force to turn a propeller set at a certain blade angle so many R.P.M. This engine, up through a certain series, takes 49″ manifold pressure to turn the propeller which is set at an angle of 18° (in low pitch) 2600 R.P.M. Therefore, to get a fairly accurate check, set the propeller toggle switch in fixed pitch position (straight up), advance throttle swiftly but smoothly until 49″ M.P. is indicated—hold just a second or two to let propeller really absorb the power and if you are getting 2600 or better your engine should be delivering 1850 HP, assuming that your tachometer and M.P. gauge are approximately correct. Push propeller toggle switch forward to automatic with propeller control handles fully forward. This will give you a check to see that the governor is set correctly. Immediately, throttle back smoothly to lower power setting. *Caution*: Do not hold engine at this power any more than absolutely necessary, and remember, you do not need this check on your engine power every time you fly. This is mainly for an engine about which you may have doubt, or if you are taking off with extreme loads or under difficult conditions, and want to be sure you have all available power. A fairly accurate check is that under same conditions as above, 40″ should give you approximately 2400 R.P.M. At this point, I shall try to explain some puzzling points on the electric propeller in order that you may more thoroughly understand the relations.

With the propeller toggle switches forward, with safety guard down, the propeller is in automatic and you have essentially the same type as a hydromatic. Your R.P.M. depends on the movement of the propeller control handles just to the right of your throttle and the R.P.M. is kept at whatever setting you want by the governor. The top limit of the governor is set, as you know, at 2600 R.P.M.; the low at approximately 1200–1300. The low pitch stop is set to hold the blade angle at 18° and the high pitch stop at 48°. *Never* open throttles to high manifold pressure with propeller governors set for low R.P.M.

When you start your engines with propellers in automatic and propeller control handles full forward, the propeller blade is down against the low pitch stop at an angle of 18° and, even though in automatic, is actually a fixed pitch propeller until, as you advance power to the high R.P.M. setting of governor, it takes control and holds the R.P.M. at whatever it is set—usually 2575–2600. Now, if you had pulled propeller control handles back approximately half way, the governor would have taken hold and held R.P.M. at that setting—we'll say, for example, 2000, no matter how far you advanced manifold pressure. This is the reason that, with propeller control handles fully forward, it is not necessary to put propellers in fixed pitch to check R.P.M. drop on each switch when you are testing mags at 2000 R.P.M.

Question: I tested my engines in fixed pitch on the blocks and got only 2400 R.P.M. at 49" but when I started take-off they went right up to 2600 and held okay. Why?

Answer: Because as you started moving, the load on your engine was lessened, allowing the R.P.M. to increase rapidly until it reached 2600, at which time your governor took hold and made the blade angle larger, allowing the propeller to take a bigger "bite" and holding the R.P.M. at 2600. The indication you got on the blocks was correct; i.e., the engine was *not* putting out its rated power.

There is a condition where the governor may bet set wrong and in running up engine with propellers in *Automatic,* you get only 2350 or 2400 R.P.M. at 49" M.P. From the above, however, you can see that it is easy to check for this condition by putting propeller in fixed pitch. If it is a governor set low, your R.P.M. will go right up to 2600–2650 in fixed pitch, depending on how good the engine is. The governor is easily adjusted to its proper setting by a set screw. Loss of power is *usually* caused by bad spark plugs, improper valve clearances, etc.

Question: Is it all right to take off with engines that you know are low on power?

Answer: Generally speaking, *NO,* if it is possible to have condition checked and remedied. As we all know, however, there may be conditions justifying the risk, so we arrive at a point of taking chances as safely as possible. Be sure your CG position is within normal limits so that your controllability will be good. Estimate length of runway—whether long enough, and no obstructions after you leave ground. In case of choice between a rather short runway directly into the wind and a long one cross wind, it would take a rather strong wind to make me select the short runway. I should estimate, off-hand, better than 20–25 M.P.H. Here, again, varying conditions forbid stating positively, but use good, *common sense.*

Several questions have been asked as to what is a good method to start engines. Of course, this is covered fully by Engine Mfg. Handbook, but here is one recommended by them, and which works very well.

With booster pump on, open throttle about 1"–1½" (not too much). After you have engaged the energizer switch for approximately thirty seconds, press starter switch, allow engine to turn a couple of revolutions, then push mixture control handle to automatic rich for a slow count of three. Pull it back to idle cut-off for a slow count of five. Then advance again to automatic rich for a count of three. Usually, it will start by this time. Sometimes, if it starts just as you go to automatic rich the second time, it may be necessary to pull it back to idle cut-off momentarily to allow engine to pick up. Of course, if it starts firing while you are in the idle cut-off position, you advance it to automatic rich. A little careful manipulation of your throttle at this point will prevent over-revving, which must be prevented. Remember for approximately the first thirty seconds do not exceed 800 R.P.M. Then, if you get an oil pressure indication, you can continue warm-up at 1000 R.P.M.

*Caution*: If a start is not made in two or three movements of the mixture control, the engine is probably loaded, so with mixture control in Idle Cut-off (important) open throttle wide while continuing to hold starter switch. When the engine starts, you must very quickly ease throttle back, and advance mixture control to Auto Rich. If engine has not started by this time, do not continue with it, for you may burn out your Booster Coil which is nothing more or less than a hot spark. Bear in mind that if you do burn it out, it is practically impossible to start, so take care of your booster coil by allowing it to cool several minutes before trying to start again.

If an engine should catch fire while starting, do not close throttle —keep starter switch on to keep engine turning and open throttle. Sometimes this will suck fire back up into cylinder. If it is determined that this will not extinguish fire, pull mixture control to Idle

Cut-Off while continuing to keep engine turning, and pull Engine Fire Extinguisher after setting pointer to proper engine. Cut switch.

Question: Is it all right to take off and land with pilot or co-pilot sliding windows open?

Answer: No. This is one thing you should get into the habit of checking just before take-off. Pilot and co-pilot should ask each other—is your window closed and locked, and is the overhead hatch securely locked? The sliding windows might fall out into the props on take-off, and of course, you know the importance of having the overhead hatch securely locked and be sure the pins are well through. Do not take any chances here. Feel and look at them. If you should open sliding windows in flight, be careful that they slide back and stay on their track. Do not push navigators hatch up unless you are at, or preferably, 10–15 M.P.H. below the allowable speed at which it can be opened. The same is also important for landing gear and flaps. Get into the habit early of staying within limits. They are put on there for the purpose of eliminating structural failures.

Question: Are booster pumps necessary on take-off?

Answer: Yes, especially in hot climates. They are not absolutely necessary in cool climates but it is advisable to always use them as they act as a safety feature in case your engine fuel pump should fail. The booster pump would give you sufficient pressure to give you all the power you need, but of course, your engine acceleration would not be as smooth as normal. Avoid too sudden throttle changes. Make them slowly and smoothly. The purpose of booster pumps is mainly for starting and to eliminate vapor locks at altitude. This is caused especially in hot climates where the temperature of the gasoline in the tanks on the ground is very high, in fact, up near the boiling point of gasoline. As you gain altitude, of course, the atmospheric pressure decreases, lowering the boiling point so that the gasoline begins to bubble and send off vapor causing locks. These are pulled through the fuel pump which momentarily has no fuel in it. This will be indicated by fluctuations on your fuel pressure gauge. These will get worse, of course, as you go higher, for the gasoline will boil more rapidly, sending off more and more bubbles of vapor. These fluctuations can be eliminated, usually, by turning on booster pumps, which are for that purpose.

## STEEP TURNS

In doing turns, always remember that you lose a certain amount of lift, which becomes accentuated the steeper you make your turn. This, in turn, raises your stalling speed rapidly. For instance, flying along with the ship "clean", that is, gear up, flaps up, and cowl flaps closed, the average stalling speed straight and level, with an approximate load of 30,000# is about 120 M.P.H. I.A.S. (indicated air speed). In a 60° steep turn, however, the stalling speed is approximately 169 M.P.H. I.A.S., so you can see that to do a 60° turn, you must keep sufficient speed at all times. You can also by sudden and hard pulls on your elevator controls, get an even higher speed stall. This is not unusual or peculiar to this airplane. It is just as true of your basic trainer, though probably not as critical. You must remember however, you are now flying a ship weighing from 30–35 thousand pounds with a very high wing loading, as opposed to a very light ship which can be built with a higher load safety factor. Do not expect the impossible of your ship. Know its limitations and what it was designed for and stay within them. To continue: Do not keep pulling in on your control column in doing steep turns, in order to try to pull nose up if it begins to go down. Ease off a little bank, get your nose back on the horizon, then roll back into a steeper bank while smoothly tightening on your control column to reestablish enough flipper force to bring you around. To be able to do a very good steep turn is a matter of practice, as you learned in flying school. I should suggest that you do not exceed a 40° bank until you have had sufficient pactice to get the feel and then do not exceed 60°, as they are pretty steep.

As you approach a stall in a steep turn, you get plenty of warning by buffeting, vibrating, shaking or whatever you want to call it, on your control column. As soon as you feel this starting, immediately ease off the back pressure you are exerting on your control column. From personal experience, I have found that you get plenty of warning to avoid stalling. Even if you should stall, do not get excited; for in most cases I have observed, the ship tends to "shudder" off into a straight stall if you will immediately release the back pressure. Give your ship time to pick up speed before you apply corrective aileron, rudder and elevator control.

Another feature you no doubt have observed is the fact that you have to carry a lot of left rudder in steep left turns in order to keep the ball centered. This is caused by the gyroscopic action of the two high-horsepowered engines and heavy propellers. This gyroscopic action tends to pull your nose up and must be corrected by really bearing down on left rudder. From the above, set youselves these rules if you are going to do steep turns of 50–60°: go into them with sufficient power and air speed (30″–2100 R.P.M.) and at least 190 M.P.H. Keep an eye on air speed—if it begins to get down to 170, ease off degree of bank, allow ship to pick up speed again and then continue. DO NOT DO steep turns at altitudes lower than 4000 to 5000′ until you are sure you are proficient and have the feel of them.

## SPINS

*DO NOT DO SPINS IN THIS AIRPLANE,* and so fly it that you do not get into altitudes from which spins will result. Practice stalls are all right but do them *power off* with your nose practically on the horizon.

The danger in doing power stalls, especially in a "clean" condition, (gear up, flaps up) lies in the fact that you will have to pull the ship into a very nose high position to reach the stalling speed. The high torque of your engines will immediately try, and *probably will,* throw you over on your back, and into a resultant spin.

## Approximate Stall Speeds

(With a normally loaded airplane)

These speeds do not apply to the B-26B-10 or B-26C Airplanes

1. POWER OFF, Flaps and Gear UP..........—120–125 M.P.H.
2. POWER ON, Flaps and Gear UP..........—105–110 M.P.H.
3. POWER OFF, Flaps Full down and Gear down—100–105 M.P.H.
4. POWER ON, Flaps Full down and Gear down— 90– 95 M.P.H.

The lower limit is the average that I have observed with a ship at about 29000 #s. Due to slight variations in ships, I have placed the upper limit which should cover most cases.

*DO NOT DO ANY TYPE OF ACROBATICS.*

## "DROOPING" FLAPS

There is a condition in which the flaps on one side may droop down from 1 to 2½" if the flap rigging is not checked often enough and set correctly. You may ask how can the flaps go down on one side only? Because, there is enough play in the linkage and bell cranks to allow this much movement when the air flow on the under surface of the wing strikes the nose of the flap, pushing it up, which in turn pushes the trailing edge down.

Question: I was doing a steep left turn when the ship suddenly tried to go over on its back. I straightened it up and it took from 5 to 7° left rudder tab. After flying for a while, it suddenly yawed to the left and I had to take most of the rudder tab off. Why?

Answer: This condition usually occurs when you are doing steep left turns and is usually one or both flaps on right side pushing out. As you reach the degree of turn you want and begin to tighten in on your control column, the flap suddenly jumps out, giving extra lift to the upper wing, tending to roll it on over. This is fairly easy in most cases to control, and is not dangerous, but admittedly is very startling if you are not familiar with it. When you straighten up, the flap in most cases is still down, setting up quite a bit of drag, which yaws the ship to the right. About the time you trim up for this, the flap goes back up and of course, since you have so much rudder tab on, the ship immediately yaws back in that direction. Sometimes, the flap may remain down partly for quite some time, until you hit a good bump, or you can "rough" your rudder back and forth which sometimes brings it back up. Flap handle UP, sometimes brings it up. If you experience this condition, have crew member in rear of ship observe if flap is drooping. Then in your remarks in your Form 1, report the condition as—"Rt. Inboard Flap and/or Rt. Outboard Flap droops 1–2 inches (or whatever you estimate) in steep turns". Then your ground crew knows to check flap rigging.

While we are on the subject of yaws, let's try to learn the relationship or causes of yaws and relatively speaking, how much yaw in degrees of rudder trim tab necessary to hold ship straight. Some of the causes of normal yaws are: one of your main gear down and the other up, or one main gear door open. This will take, as I remember, about 5° of rudder trim. A cowl flap full open on one engine and full closed on the other will take 1–2°. All these figures are approximately, for frankly, I never stop to think of how much trim tab I am having to use—I use whatever is necessary to correct the conditions. That, I believe, is a good rule to follow unless you want to write up a definite report. I am speaking now of normal changes in rudder trim, which you instinctively correct for, first, by applying opposite rudder to bring the nose back to proper heading and then by applying proper rudder trim to relieve the pressure on your foot and leg. It is when you get abnormal yaws that you must be on the alert, and they usually are caused by complete or partial engine failure.

Question: How can I tell whether it is an engine failure when the manifold pressure remains the same and the R.P.M. remains the same?

Answer: Unless the engine has failed structurally, tending to sieze, the prop will continue to windmill and the governor will keep it at, or near the R.P.M. at which it is set. This in turn keeps the impeller in the blower section turning, which keeps manifold pressure showing on the gauge, even though engine has lost all or most of its power. You could advance or retard throttle and you would get a normal indication. Therefore, if you are flying along and your ship suddenly pulls to one side, your instinctive reaction and the *very important* one is to apply opposite rudder and aileron immediately to bring ship back to heading and keep wing level or slightly low. Do not hestitate to really bear down on opposite rudder to keep ship heading straight, for this keeps you from losing air speed rapidly and *remember,* the slower the air speed, the *more* rudder forces necessary to keep ship under control. Now, we have done the first and what I consider the *most* vital and important movement in any emergency, and that is—Get and Keep your Ship Under Control. Make no abrupt or violent movements of your controls and do not make the common mistake of letting your nose go way up or down. Now that you are headed straight, holding ship level, reach up and quickly take the force off your foot and leg, with the rudder trim tab, in order that you can begin to investigate. And here let me emphasize, that rudder control is the thing that really holds the ship. You need very little aileron tab (in fact, I use none) and it acts as an additional drag, so the less you use, the better. This has only taken a second or two and while you were doing it, you should have taken a quick glance at your fuel pressures. If you see that it is falling or has gone down completely, this, accompanied by the yaw and the fact that your air speed is dropping, is definite proof that you are losing, or have lost that engine, so single engine operation is indicated. If you have sufficient altitude, do not feather the prop too quickly—throttle your bad engine back to keep it from throwing you the other way if it comes back on, and expend a few seconds in determining what kind of failure it is, and whether you think you can get partial power from the engine. When you decide definitely that it is out, or that you are losing altitude and can't wait any longer, Feather bad engine Immediately. Keep under control at any cost, even if it means losing altitude. Your single engine performance depends on your load, CG position and your ability as a pilot. If you see you can't hold control and altitude, ease nose down as smoothly as possible to pick up air speed, *which will increase your control*. Sometimes by sacrificing a few hundred feet, you increase your performance to where you can hold with sufficient control at the low altitude. If in the last dire emergency, you can't hold altitude, remember again, KEEP UNDER CONTROL no matter what type of terrain you must land on. Observe the usual crash landing technique and make as normal a landing as you possibly can, completely under control until the last second.

Suppose we take the opposite condition of the above. We are flying along normally and see a fuel pressure dropping, for instance on the right engine, but there is as yet no apparent tendency to yaw to the right. Get set by holding left wing down slightly and being prepared to hold left rudder. Watch fuel pressure—if it drops on down below 6–8# (which is your normal booster pressure), put booster switch ON and see if pressure goes up to around 6–8#. If it does not, and you still have experienced no yaw to the right, you can be pretty sure that your autosyn instrument is out and your fuel system is O.K. If pressure had gone up to normal booster pressure, it probably would indicate that you were having some sort of fuel pump trouble or a fuel leak somewhere. The engine will run all right on booster pressure but you should land at the nearest available field to have this checked. Also, while your engine is performing all right, get altitude as a safety precaution, but *do not* climb at *too low an air speed* in case engine should quit. Keep at least 160 M.P.H.

There was a condition where we had *three* pretty definite indications of engine failure: (1) a fairly violent yaw which will take about 8–15 degrees of rudder trim tab to hold ship straight, accompanied by (2) a definite loss of from 30–40 M.P.H. air speed to hold your original altitude and (3) the indication of fuel pressure loss. Suppose we had the first two, but fuel pressure remained normal, which it would do if the fuel pump was O.K. because the engine is still being turned by the windmilling prop. We would, in that case, have absolutely no instrument indication of failing engine, but would have one, nevertheless. In other words, as far as I can tell, the two prime indications of engine failure are: the amount of rudder necessary to keep ship straight, accompanied by a definitely large drop in air speed. Here is where experience enters the picture, for a drooping flap of about 2 or 3″ on one side will take approximately 5 degrees rudder trim and may slow air speed about 10 M.P.H. This may cause you to believe you have an engine failure, but you can easily check to see if flap is drooping, and I can almost definitely say that an engine failure will require from 8 to 15 degrees rudder tab (depending on air speed you can hold), and you will lose at least 30–40 M.P.H. from a cruising speed of 190–200 M.P.H. Another corroborative indication but one which will take a short while to show up, is along with this condition of loss of air speed and excessive rudder trim, the cylinder head and oil temperature will begin to fall.

Of course, a popping or backfiring engine will indicate itself. This can be caused by several things—improper mixture, sticking valves, temporary starving for fuel, etc. and other causes with which perhaps, I am not familiar.

To cite one case of this: I had been flying a ship for about one and a half hours, had finished all the routine check and was cruising around practically "half asleep" when the left engine suddenly choked and back-fired, and felt as though it was going to "jump out of the ship". I immediately got the ship under control and gradually throttled the engine back, while at the same time checking instruments, all of which were normal. I had been cruising in Automatic Lean so I advanced to Automatic Rich, thinking perhaps something had gone wrong with the automatic mixture setting. As soon as I had throttled engine down, the backfiring stopped and I discovered by keeping the setting at 20″ or less, the engine ran quite smoothly, but as soon as I would advance it, the backfiring would commence again. Then I tried the differeent mixture settings and discovered that they had nothing to do with the problem, for the engine above 20″ M.P. would backfire at any setting. In the meantime I had headed for "home", about 40 miles away, and by flying with the slightly unbalanced power setting of 20″ M.P. on left engine and 28″ M.P. on the right engine, I had no trouble at all flying with practically normal air speed and normal amount of rudder trim. A normal landing was made with no difficulty. In practically every case of an engine "acting up", you can secure fairly good performance by throttling back until you find the smoothest setting. This in many cases prevents a complete failure on an engine and gives you just that extra power needed to get home comfortably. To use a homely simile—"pet a sick horse and lighten his load and you can still get lots of work from him, but push him too hard and he drops dead".

The ground crew checked that engine and found a couple of valve springs broken.

Another case where lower power settings might keep an engine going would be—a fuel line partially clogged, not allowing enough fuel for high power settings but sufficient for lower ones.

The most critical time at which a complete engine failure can occur is just after leaving the ground when you are practically at stalling speed with full take-off power on. This is the bugaboo of all pilots and your reaction must be of the quickest to avoid crashing out of control. The only possible way would be to cut both throttles in that split fraction of a second when you felt the ship trying to go out of control, and immediately apply rudder and aileron control to straighten the ship out. In this way you could crash straight ahead. Many questions have been asked me whether this ship would take off on one engine. That is like asking if a single engine ship will take off on ½ engine, and the answer as I have said several times, depends on load, the amount of air speed *above* stalling speed you have acquired, available remaining power which you can control, and your ability as a pilot. The whole problem is relative, and this ship is as good as any when all the features of its design are taken into account.

I do not like to quote specific figures, but so many questions are asked me to give an estimate that I shall quote a problem and tell you what I honestly believe from the indications I have received in practice. This is general only and can vary under a lot of conditions. With a normal ship loaded at 30,000 lbs., CG position at about 21% M.A.C., or anywhere within limits, I believe that I can continue to take off if an engine quits, after I have reached or passed 150 M.P.H. with my gear up, or practically so, and further, I wouldn't hestitate to try to keep going even under more adverse conditions, but as soon as I realized I couldn't control it, I would endeavor to keep control even at the expense of reducing power on the good engine. That is the reason, I always advocate getting single engine air speed as soon as possible after take-off. In other words, a very normal climb consistent with safety in passing over obstacles.

## CG

Perhaps you are getting tired of hearing so much about CG positions, etc., but you *must* learn and appreciate how much and how seriously it can affect flight characteristics, looking at it especially from a standpoint of control safety and how it also affects the general over-all performance which some day might just make that small difference which might give you another few minutes or so flying time to reach home safely. Right now ask yourselves: Do I want to expend a little time in study and thought to try to make myself an expert pilot, who not only can fly, but who understands and appreciates the many varying factors connected with safety and the securing of maximum performance from my equipment? If so, you must continually study and practice.

The CG position you hear so much about is nothing more or less than the "point of balance". That is the point in the airplane, at which, if a strong enough cable were tied, the airplane would balance when lifted. Now you can make this CG or balance position vary by shifting load further aft or further forward. A simple illustration is two boys, each weighing fifty pounds, on a see-saw board 20 feet long. The point of balance there would be exactly in the center, or 10 feet on each side, giving a moment of 10 x 50 or 500 ft. lbs. on each side. Now place a 200 lb. man on one end and where do we have to shift the board? To a point where the 50 lbs. boy will have 16 ft. of the board on his side. (16 x 50 = 800 ft. lbs.) and the man will have 4 ft. (4 x 200 = 800 ft. lbs.) on his side. You can see at once that though they are balanced, it would be more difficult to control accurately from the short side with the heavy weight, than it would be if you were on the boy's side, with the long 16 ft. leverage.

We won't try to go into all the other forces entering into the picture; and how inertia builds up, etc., but reduced to simple terms, we know that the airplane tends to become unstable (not dangerously so) as the CG or balance position approaches the limits recommended by the airplane manufacturer. When it goes beyond, it tends to become dangerous, and how much so depends on how heavy the load and how far beyond limits the CG is. The design engineers have figured these limits and they have been tried out in actual flight test, so when they tell us what these limits are to make control easy and safe, the least we pilots can do, is take a little time in seeing that we so distribute our load that we make the CG fall within its proper limits.

With an extreme forward CG, you could be so "nose-heavy" that it would be difficult on take-off to raise nose high enough to get enough angle of attack on wings to take off. On landing, it would be hard to get nose-up in time to make a good landing, and there would be too much load forward on your nose wheel after landing.

With a bad aft CG position, which makes the ship "tail-heavy" (which is the worst position from a standpoint of loss of control) the nose would tend to come up too easily, and immediately after take-off the amount of control we would have at that slow air speed would be so small, that it would be extremely difficult to get nose down enought to pick up proper air speed. This *could* be so bad that the ship would go into a stall and crash out of control, but of course, this is a very extreme condition.

Cruising along in the air with a CG too-far aft, you will experience the following : when the nose goes down for any reason (a bump, or one of the crew members moving around), it does not tend to come back level where you had it trimmed, but keeps on going down, and you have to apply control. Conversely, if it goes up, it tends to keep on going up, and you have to "fly" the airplane all the time. The seriousness of this, naturally, depends on how much force is necessary on the controls to bring it back level. You will find this to a small degree, with a CG position at the back limit (24% MAC) which is normal, but perhaps makes us work just a little more at flying the airplane.

You will have MAC (mean aerodynamic chord) and how to figure CG positions in your school curricula, so I will not go too deeply into it, but while we are on the subject, I shall cite a specific case and how one officer learned about the importance of loads and CG position.

He was going on his first bombing practice and had his ship, which had been used for transition training, loaded approximately as follows: pilot, co-pilot, three men in navigator's compartment, two men under rear turret, 800 lbs. of bombs in forward bomb-bay, 700 lbs. of bombs in aft bomb-bay, 200 lbs. of ballast at camera position and about 1000 rounds of ammunition at the various gun positions. He also had full main and auxiliary wing tanks. He took off and experienced great difficulty in holding nose down, but managed to circle the field a couple of times and landed O.K. As he explained it to me, "I didn't exactly know what was wrong, for the ship had never flown like that before, but I knew that I should land and have it checked". There was some criticism of him for several of the fellows remarked that that was not too much load, and others thought there was something wrong with the airplane itself. There was nothing wrong with the airplane and although he was fairly heavily loaded (34,280 lbs.) this was not too much. However, I figured his CG position roughly and found it to be almost 27-½%, which although controllable, perhaps, (since he got back safely) is definitely approaching a dangerous condition. For instance, suppose he had been forced to make a steep diving turn suddenly to avoid a collision with another ship. You can see how hard, or perhaps even impossible, it would have been to regain control. Most of the fellows said "if he had removed the ballast, he would have been O.K.". On first thought this sounded reasonable, but I thought it better to figure it out to actually determine whether this were true or not. When actually figured, this only brought his CG forward to approximately 26.8%, which still wasn't enough, so we moved the extra two men forward to the navigator's compartment, refigured and found that this moved his CG forward to 24.1%, which was O.K.

Now you see how easy it would have been for him to have taken off with a safe ship instead of trusting to luck and taking off with a dangerous one. Due to his excellent judgment in deciding to return when he found a condition with which he was not familiar, and due to his skill as a pilot, he returned safely and now has learned how to figure for himself this important CG position.

The simple act of removing the ballast for that particular flight, and having all five crew members forward, would have given him a ship within safe limits. After he had reached his cruising level and trimmed out, the two crew members could have returned safely to the rear of the ship. From this we learn that even though we should get caught with an extreme "tail-heavy" condition—we can move ballast (especially crew members) forward until our ship "feels" more controllable, remembering also that for every minute we fly, our CG position moves forward. Why? Because we are consuming fuel which is always aft of the basic weight empty CG position of the ship to which all additional moments are added. This is very important to know also. After a long flight on which a great deal of fuel will be consumed and perhaps 2000 lbs. of bombs will be dropped, what will the CG position be? This is very easy to figure and only takes two or three calculations.

## HINTS AND TRICKS

### *How to Quickly and Accurately Trim a Ship at Cruising Speed*

Synchronize engines at 2000 R.P.M. and balance power at 28" M.P., or whatever power setting you desire. This is important before you can start accurately to trim the ship. Now with wheel *hold* wings level, ease pressure of your feet off rudder pedals, and observe where the ball in your bank and turn goes. If it goes to the left, apply left rudder tab (while continuing to hold wings level) until ball stays centered and no turn is indicated on your Gyro Turn

Indicator. Now release pressure on aileron control and if ship is right wing heavy, turn aileron tab to left until the wings remain level. You may have to take off just a fraction of the rudder tab you applied. This should give you quickly and accurately a setting which will be the proper trim for that speed. Always apply rudder or rudder tab on the side where the ball is, if your wings are level.

Another tip—if you are holding ball centered (ship straight) and feel a rudder "pushing back" on your foot, apply rudder tab on that side. Pressure on left foot—left tab. Pressure on right foot—right tab, until your rudder pedals feel equalized.

Tip for elevator trim. As you level off for cruising and get your desired settings, allow ship to pick up speed while trimming for nose-heavy or nose-up. As a general rule, unless you applied too much forward elevator trim when you first leveled off, the tendency will be for the nose to rise as you pick up speed. Keep making small forward corrections on elevator tab until you get the rate of descent showing slightly down but the altimeter showing no loss in altitude. A good pilot can sometimes get 5 to 10 miles per hour more out of a ship holding same power and altitude, as compared with another pilot who doesn't bother to make this fine adjustment. Another hint on getting set for cruising, is to go several hundred feet above your desired cruising altitude and come "down hill" to the desired altitude while making your desired settings. This gives your ship a chance to really start rolling.

Another thing you should learn early in order to take good care of your engines, is the relationship between R.P.M. and manifold pressure. In extreme cases, the engine manufacturer sets the absolute limits of the various combinations but a general rule to remember is never have too high a manifold pressure without a corresponding high R.P.M. For instance, do not have, we'll say, 40″ of manifold pressure with only 1800 R.P.M., or conversely, taking an extreme case, do not have 2600 R.P.M. and no manifold pressure. In the first case, you run the risk of having a cylinder head blow-off, and in the second case, you are throwing terrific inertia loads on your wrist pins, etc. Also remember the standing rule that in reducing high power settings, always reduce manifold pressure first and then R.P.M. and to do so in increments. A fairly good rule of thumb is for every 4″ of manifold pressure, reduce 100 R.P.M.

Question: Is it all right to cruise in automatic lean?

Answer: Absolutely so, in order to economize on fuel, but there are limits of power settings which you can find in the Engine Manufacturers Handbook, and which I believe is approximately 32" manifold pressure and 2100 R.P.M. Of course, you know that take-offs, landing climbs or any maneuvering which will take extreme ranges of power, must be in the automatic rich position.

## HINTS ON SINGLE ENGINE FLYING

Single engine practice should be obtained with a qualified instructor and this is part of your check-off. However, I'll list some hints on obtaining the best performance possible.

Keep wings nearly level, with *good* engine wing down only about 5 degrees. The more nearly level, the better the performance, but, the lower the pulling engine—the better the control, and this gives a lesser amount of rudder necessary to hold ship straight, which in turn reduces the loads and stresses on the rudder itself. So you can see that a compromise must be made, depending on which of the two above factors is the more desirable under certain conditions.

Opinions vary, but I always recommend practicing single engine with an engine idling. This is for two reasons: (1) If you learn to fly successfully on one engine with all the drag of one windmilling, you can fly and handle it immeasurably better with the propeller feathered. (2) When you practice with prop feathered, you have deliberately placed yourself in a semi-emergency condition, and it takes much longer to start and warm up than it would if engine were idling.

A good point to know is, that with prop windmilling, you can increase single engine performance by pulling the Prop Governor Control full back to High Pitch (low R.P.M.) position on the windmilling engine. This would be especially valuable in case you had a real engine failure, and neither the feathering switch nor the decrease R.P.M. switch would work for any reason.

The reason reducing R.P.M. on the windmilling engine gives better performance is because the blade angle is out to its biggest angle (48°), which reduces the frontal resistance and also reduces the amount of energy the prop is expending in turning the windmilling engine's pistons, engine accessories, etc.

In case you do not already know it, the Decrease R.P.M. Switch will feather a prop, but more slowly than the feathering switch, because when it is used, the normal ship voltage is running the prop motor. When the feathering switch is used, all it does is boost the voltage up about 3½ times, which of course speeds the prop motor up, making the prop feather in about 8 seconds. Naturally, the prop manufacturers have built the motor to withstand this higher voltage but it is definitely somewhat of a strain if continually used, so the intelligent and safe thing to do is use the slower, but just as effective Decrease R.P.M. Switch.

Let's take some sample cases of loads, etc. and assume a problem. Suppose we have started out on a bombing mission with a total load of 34,000 lbs, which includes 2,000 lbs. of bombs. We have been out over water for about 30 minutes and have reached 5000 ft. altitude when an engine quits. We immediately go on single engine with prop feathered, but find we can't hold altitude with proper control. We have a load which we can jettison but know that it takes a certain amount of time for the bomb bay doors to be open and that there will be a good bit of drag while they are open. In that case, I would take all the power from the good engine that I could hold, while gently nosing ship down until I got about 170 M.P.H., at which time I would salvo bombs.

The higher air speed would give you control when the bomb bay doors opened and you should be able to hold altitude with the 2000 lbs. away, plus the amount of gasoline you had used up in take-off and 30 minutes of flying. We'll estimate 100 gallons or 600 lbs. That would reduce your load to (34,000–2600) or 31,400 lbs., and you should be able easily to hold that at an altitude of 2000–3000 ft.

You could do the same thing with bomb bay tanks, or in an extreme case, have all your crew bail out if you were over suitable terrain. In that way, you might be able to bring your ship down safely, where otherwise you might crack up with all the crew aboard. You can see that this losing altitude under control is not as foolish as it sounds, for as you descend, your single engine performance increases with the same load. In other words, with a loading that you can't quite hold at 10,000 ft., you can hold quite comfortably at 5,000. Of course, you don't stick your nose down and dive to a lower altitude. You lose as little altitude as possible and at as slow a rate of descent as possible, until you find the point at which you can maintain level flight.

Question: How much power should I use on the good engine?

Answer: Just enough to give you comfortable control to maintain desired altitude. Of course when you first suspect engine failure, go back to the prime rules—Get and Keep Control and immediately advance your good engine up to rated power, (2400 R.P.M. and 38″ M.P.) if you can hold it. If not, of course, as nearly to that figure as you can. This keeps your air speed up while you are trimming out and trying to discover what is wrong. After you have the situation in hand and find that this gives you more speed than you actually need, throttle back to about 34″ M.P. and 2300–2350 R.P.M. In most cases with normal loads, this should give you about 160 M.P.H. and will enable you to hold altitude O.K. The reason for doing this is to take care of your *one* remaining engine—to prevent it from overheating, etc.

If there are some of you, who have been checked off and had quite a bit of time on the ship, but who never received any single engine instruction, here is a good way to practice safely and teach yourselves. Go to a safe altitude (at least 5000 ft.) and stay near a suitable landing field. While cruising along with ship trimmed out properly, pull slowly one throttle back to about 20″. Get used to the amount of rudder force necessary to hold this unbalanced power setting. Now trim this out with rudder tab, and then advance the power back in its normal setting, getting the feel of this. Retrim again for normal cruising. In other words, what I am trying to tell you here is, to practice until you become thoroughly familiar with unbalanced conditions and how to actually hold it with rudder itself while you are trimming out. In the same unbalanced condition as above, and before you trim out with your rudder tab, notice how you can relieve the pressure you are having to exert on the rudder pedal by dropping the good engine down, and/or increasing air speed.

From this you gradually work to the point where you have completely retarded the throttle on one engine, and soon you will discover that you are perfectly competent to fly on one engine within the limitations I have been describing.

If at any time your ship feels as though it is getting away from you, reduce power on your good engine, drop nose to pick up air speed and get ship back under control, at which time you can either continue with your single engine practice, or if you have lost too much altitude you can resume with both engines balanced.

Don't practice too long with an engine completely idling because it is cooling off and damage may be done to it if you resume higher power too suddenly. Let it run awhile at 12–15" to warm it up gradually before returning to normal cruising.

## TO ALL PILOTS, OR OTHERS, WHO HAVE READ THE FOREGOING

This has been written rather hurriedly, without too much care being given to grammatical construction and proper grouping, but if it contains anything that you feel may be of value to other pilots coming along, this can be remedied by reprinting. I should appreciate any comments, criticisms, suggestions or other questions which should be answered, addressed to me

Chief Production Test Pilot,
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Baltimore, Maryland

Let me know frankly if you think this will really be of any value to other pilots in helping them to more properly understand their airplane in order to get the best performance from it. If this is decided, this rough draft can be re-written and perhaps printed in the form of a small pocket manual.