WIRRAWAY TRAINING NOTES FOR FLYING INSTRUCTORS

CENTRAL FLYING SCHOOL

R.A.A.F.

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CONTENTS

WIRRAWAY TRAINING NOTES

INTRODUCTION

These notes are intended to supplement the system of intermediate training as detailed in Part II of A.P. 1732. They have been compiled at C.F.S. for the guidance of Service Flying Instructors, and are intended to cover the operation and flying of the Wirraway Aircraft.

The sequence of instruction used is in accordance with A.P. 1732.

A thorough study of the Wirraway and Wasp handbooks should also be made as they contain much additional information that is essential knowledge for the Wirraway pilot.

WIRRAWAY AIRCRAFT

1. FAMILIARITY WITH COCKPIT LAYOUT

Before a pilot flies a Wirraway for the first time it is essential that he is made conversant with the cockpit layout, the use and operation of any instruments and ancillary controls strange to him, and the petrol, oil and hydraulic systems. The operation of the flaps and the undercarriage can be demonstrated on an aircraft jacked up with the wheels clear of the ground. It is not possible to use the engine driven hydraulic system in this instance, but the hand operated system can be demonstrated. (See Emergency Operation—Sequence 1F).

The method of holding the "spade grip" of the control column and of using the brakes should be shown at this stage.

1A. PILOT'S PRELIMINARY CHECK BEFORE STARTING ENGINE

1. Make a thorough external check of the aircraft, including chocks in front of wheels.
2. If going solo, before getting into the aircraft, make sure that the rear cockpit is fit for solo by checking—
   (a) that the rear control column has been removed and stowed.
   (b) that the safety belt is on the clips provided.
   (c) that the rear speaking tubes are secure.
   (d) that the rear cockpit sliding roof is closed and locked.
3. Apply parking brakes.
4. Unlock controls and test for free and correct movement.
5. Adjust rudder pedals to suitable length.
6. See that the blind flying hood is secure.
7. Adjust seat to most comfortable height for clear vision.
8. Buckle up and adjust safety belt.
9. Order the master switch to be turned on.
10. Test operation of the hand pump by pumping the flaps partly down and up again.
11. Switch on fuel gauge lights and check contents of both tanks.

1B. STARTING UP PROCEDURE

1. Turn petrol cock to "reserve tank on". Ensure that the rear cock moves correspondingly. The reserve tank is used to start and warm up the engine and the right tank to run up and taxy out, in order that the supply lines from each may be tested prior to take off.
2. Pump up the fuel pressure with the wobble pump to 3 lbs. sq. in. avoiding excessive use of the pump owing to the possibility of fire. Three to four strokes are normally sufficient.
3. Place the mixture control in the fully "lean" (full forward

position), and prime the engine by pumping with the throttle lever to the full extent of the quadrant. When cold six to eight strokes, when warm two to three strokes, when hot nil to two strokes.

4. Open throttle approximately half an inch on the quadrant.

5. Return mixture control to fully "rich" position. Renew fuel pressure with wobble pump.

6. Check pitch fully fine.

7. Call "ALL CLEAR" and wait for reply.

8. Call "CONTACT" and turn ignition switch to "BOTH".

9. Press starter button. If the engine misfires and does not pick up quickly, do NOT pump the throttle, as this may flood the carburettor and cause fire. Do not release starter button till engine fires properly.

NOTE.—For cross-country flying, "right tank" is first used, then "left tank" and finally "reserve". Therefore, when starting up before a cross-country flight turn petrol cock to "left tank on".

1C. SYSTEMATIC CHECK OF INSTRUMENTS AND CONTROLS WHILST WARMING UP

When the engine is running smoothly, and an oil pressure is registered, open the throttle to 1000 revs., and allow the engine to warm up. While the engine is warming up, carry out a complete cockpit check, being careful to adopt a systematic method, i.e., work from left to right.

1. Test engine driven hydraulic pump by lowering and raising the flaps. Check reading of pressure gauge with power valve in (normal 850 lbs.), movement of flap indicators and serviceability of warning lights.

2. Undercarriage selector in emergency "down" position.

3. Carburettor heat control in fully "cold" position.

4. Cage Sperry instruments.

5. Check all instruments as far as possible for serviceability.

6. Set altimeter at zero.

7. Turn on carburettor air temperature switch to position No. 1. Notice that this energises the exhaust gas analyser.

8. Turn gyro selector valve to "vac. pump on", to test suction (2 to 4 ins.). If instruments are not to be used turn "off".

9. Switch on generator main line switch, and make sure no discharge is indicated.

10. See that the tail wheel is unlocked.

1D. TESTING ENGINE

1. Before running up, the following minimum temperature must be obtained—cylinder head, 150 degrees C.; oil, 50 degrees C.

2. Ensure that the slipstream will not affect aircraft behind or blow dust into the hangars, etc.

3. Turn fuel cock to "right tank".

4. Throttle on slowly to 1500 revs. Test magnetos by turning switch from "Both" to "Right" then to "Left" and back to "Both". A drop of 100 revs. is permissible—150 on one magneto, provided the engine runs smoothly.

5. Hold control column right back, and open throttle slowly to 30 in. boost. Check revs., which should be 1850 to 1900; oil pressure, 90 to 100 lbs.; fuel pressure, 3 to 5 lbs.

6. Throttle back and test idling adjustment.

1E. STOPPING ENGINE

1. Throttle back to approximately 600 revs.

2. Move mixture control to fully "lean" position. When airscrew has stopped, carry out a systematic check from left to right.

3. Return mixture control to fully "rich" position.

4. Turn petrol off.

5. Turn magneto switches to "off".

6. Apply parking brakes.

7. Switch off carburettor air temperature switch.

8. Turn vacuum selector to "off".

9. Switch generator main line to "off".

10. Lock tail wheel.

11. Switch off fuel gauge lights.

12. See that the master switch is turned off.

13. Lock the controls, if circumstances demand it.

1F. EMERGENCY OPERATIONS

UNDERCARRIAGE

1. With engine running, the engine-driven hydraulic pump is used to operate the undercarriage and flaps. If the engine is not turning, or the engine hydraulic pump fails, then the hand-operated hydraulic pump must be used. Under these circumstances, the operating procedure is exactly the same, except for the use of the hand hydraulic pump instead of the engine pump. For example, to lower the wheels—

(a) Test warning devices by throttling back.
(b) Select wheels to "down" position.
(c) Engage hydraulic power valve.
(d) Operate hand pump (when operation is complete, it will become impossible to move the pump lever).
(e) Selector to emergency "down" position.
(f) Release hydraulic power valve.
(g) Test warning devices to ensure wheels down.

2. Should the above method fail to lower and lock the undercarriage, the final emergency method is—

(a) Select wheels to "down" position.

(b) Release pressure in hydraulic system by unscrewing the emergency release cock, which is painted red and is situated on the left hand side of the pilot's seat.
(c) Rock the aircraft violently in the fore and aft, and lateral planes.
(d) Place the undercarriage selector into the emergency position.
(e) Test audible warning device.
(f) Close the emergency release cock, as this may allow the operation of the flaps in the normal manner.

3. Should the undercarriage lower (visual indicators in "down" position) but fail to lock, which will be denoted by a continuous blowing of audible warning device, an emergency landing as follows is to be carried out, **provided it is on an aerodrome and surface is known to be good—**

(a) Place undercarriage selector in "down" position.
(b) Engage hydraulic power valve.
(c) If possible place undercarriage selector in emergency down position; if not possible and horn continues to sound, return undercarriage selector to midway between up and down positions. The hydraulic power valve MUST be still engaged during this operation.
(d) Release the hydraulic power valve.
(e) Pressure of 850 lbs. per square inch should now be locked in the hydraulic undercarriage lines, and this will be indicated on the hydraulic gauge.
(f) Should the valves be leaking and the pressure falling off, repeat the operation and this time build up a higher pressure with the hand pump, then lock the pressure in the lines as before.
(g) Make a wheel landing, being careful not to swing or apply the brakes. After coming to rest, leave the aircraft heading into wind, switch off engine and exercise care in getting out of the cockpit.

4. Should it not be possible to LOWER the undercarriage, or should it be possible to lower the undercarriage but NOT to LOCK it, and an aerodrome with a good surface is not available, then a landing with the undercarriage RETRACTED will be made. Damage to the flaps may be prevented by selecting up just before the touch down.

FLAPS

To lower the flaps—

(a) Select flap lever to "DOWN" position.
(b) Engage hydraulic power valve.

(c) Operate hand pump. (When operation is complete it is impossible to move the hand pump lever).
(d) Disengage hydraulic power valve.
(e) Lock flaps.

INSTRUMENTS—ICING CONDITIONS

The altimeter, airspeed indicator and rate of climb indicator depend upon the efficient operation of the pitot head for their accuracy and recording. Should adverse weather conditions be encountered and ice formation affect this unit, trouble may be overcome by putting the pitot heat switch to "On". This switch should not be "on" when the aircraft is on the ground.

CARBURETTOR ICING CONDITIONS—

If carburettor icing conditions are suspected, carburettor heat control is to be used. Backward movement of the control lever increases the carburettor air temperature. Operate the lever to give a carburettor air intake temperature of + 32 degrees C.

NOTE.—For training, the hot air duct has been blanked out and if the heat control is required, the blanking plates must be removed. (Wasp Order No. 22).

FUEL PUMP

Should failure of the engine driven fuel pump occur, the hand pump must be used to provide a supply of fuel to the carburettor.

VACUUM PUMP

In the event of failure of the engine driven vacuum pump and consequent failure of the gyro instruments to function, the vacuum selector valve should be turned to "venturi on", thus bringing into operation the venturis which allow the gyro instruments to operate individually of the power operated vacuum pump.

2. EFFECT OF CONTROLS

The controls are light and responsive, particularly the elevators. In addition to the elevator trim, which is very sensitive, a rudder trim is also fitted to this aircraft.

3. TAXYING

To taxy, place the feet on the rudder pedals so that the instep rests on the lower portion of each pedal, thus leaving the toes free to operate the brakes independently.

Hold the control column central and place the elevator trim at neutral, i.e., 12 o'clock.

Control the aircraft primarily by coarse use of the rudder assisted by engine and brake in the required direction, as necessary. Reduce throttle variations to a minimum and avoid prolonged idling below 800 revs. Use the brakes sparingly.

The view ahead is much more restricted than in an elementary trainer, thus it is necessary to yaw the nose very frequently. The view ahead may be increased by raising the seat to its uppermost position.

Never turn the aircraft unless it is moving forward, otherwise damage will be caused to the tyre of the stationary wheel and also to the undercarriage.

4. STRAIGHT AND LEVEL FLYING

To fly straight and level, set the boost to 26 in. and the revs. to 2000 r.p.m. Adjust the vertical speed indicator to zero and notice that the airspeed should be approximately 145 m.p.h. Trim the aircraft to fly level at this speed. Notice that the elevator trim is very sensitive. Check for constant height on the altimeter. Use the rudder trimming device to assist in maintaining direction. The direction indicator should be referred to. Notice the position and attitude of the aircraft in relation to the horizon and position and attitude of the image in relation to the artificial horizon.

For continuous cruising, it is important that the most economical mixture be used. To achieve this, the mixture control must be used above 5000 feet (see Appendix E, Exhaust Gas Analyser).

5. CLIMBING

To climb the aircraft set the revs. at 2100, open the throttle to 28in. boost, at the same time reduce the speed to 110 m.p.h. Trim the aircraft for this attitude and note the position of the nose in relation to the horizon.

Do not climb straight ahead for too long, but move the nose occasionally to ensure that all is clear.

As height is gained the boost will fall off; thus to maintain climbing boost (28 in.) the throttle must be progressively opened.

Above 5000 ft., the mixture control must be used to keep the mixture correct. Ease the mixture control forward and check the reading on the fuel-air ratio gauge. The correct reading is .078; and the minimum reading .072. The mixture control should be opened slowly because of the lag in recording of the instrument. An approximate guide for the correct setting is with the leading edge of the mixture control just behind the trailing edge of the throttle. On no account should it be forward of this position.

The cylinder head temperature should be watched and if the temperature rises above the maximum of 260 deg. C., the speed should be increased. It should also be watched when the mixture control is used as too weak a mixture will cause a rise in temperature.

FLAPS UP

5A. GLIDING

To glide close the throttle, keep the nose up and assume the gliding speed of 100 m.p.h. Trim and note the position of the nose.

Care must be taken not to allow cylinder head temperature to fall below 90 deg. C.

Do not allow the engine to "pop back" unduly. To overcome this open the throttle slightly.

NOTE 1.—Normal method of losing height in a Wirraway is by diving, but if revs. are 2000 or more the boost must be at least 25 inches.

To lose height without gaining speed, first reduce revs. below 2000 and then throttle back.

FLAPS DOWN

Now lower the flaps and assume the correct gliding speed of 90 m.p.h. Trim and note that the position of the nose is much lower and the angle of descent much steeper.

5B. STALLING

This aircraft stalls in a normal manner for a high wing loaded monoplane. Compared with the stall on the elementary type, it occurs more suddenly, at a higher speed and a wing may drop, perhaps violently, according to the manner in which the aircraft is stalled.

The approach of the stall is heralded by progressive loss of control, a feeling of instability and finally by considerable vibration.

Every aircraft will stall at varying speeds and varying attitudes and these speeds and attitudes at which it stalls are determined by three factors.

(1) Thrust from the airscrew.
(2) Position of the flaps, i.e., up or down.
(3) The loading, either static and/or aerodynamic.

Place the undercarriage in the DOWN position, to prevent the horn blowing.

Demonstration 1—Stall WITHOUT Engine and Flaps UP

Close the throttle and reduce speed by a gentle backward pressure on the control column, keeping the nose just above the horizon. Notice the progressive loss of control, particularly in the pitching plane. Notice the vibration. With the airspeed at 65 m.p.h., the aircraft stalls and a wing may drop. Recover by moving the control column forward, opening the throttle and keeping straight by use of the rudder. When full flying speed and control have been regained, ease the aircraft out of the dive. On no account must an attempt be made to correct a dropped wing at the point of stall by opposite aileron as this may have the reverse effect to that desired and induce autorotation. A dropped wing must be corrected by opposite RUDDER. Notice that the nose of the aircraft at the point of stall was just above the horizon.

Demonstration 2—Stall WITH Engine and Flaps UP

Reduce boost to 20 in. and reduce speed by a gentle backward

pressure on the control column until the aircraft stalls with the nose about 45 degrees above the horizontal. Notice that it stalls much more reluctantly and at a lower airspeed, i.e., about 60 m.p.h. Also notice that the nose was a long way above the horizon. This lower stalling speed and higher position of the nose are due to thrust. Recover as before.

Demonstration 3—Stall WITHOUT Engine and Flaps DOWN

Close the throttle and reduce speed by moving the control column back at the same rate as in the previous demonstrations. The aircraft will stall at about 60 m.p.h. Notice that the position of the nose at the point of stall is lower than in the first demonstration. This lower stalling speed and lower position of the nose than in the first demonstration are due to the effect of flaps.

Demonstration 4—Stall WITH Engine and Flaps DOWN

Reduce boost to 15 in., i.e., about the same amount as used in a powered approach and reduce speed by a gentle backward pressure as in previous demonstration. Notice that the aircraft is very reluctant to stall until at a speed of about 52 m.p.h., it stalls as before. Recover as before.

This very low stalling speed is due to the combined effect of thrust and flaps.

It can be seen from these demonstrations that the aircraft stalls at the lowest speed when thrust is present and flaps are down. These conditions are fulfilled for a normal landing approach.

HIGH SPEED STALL

Every aerofoil has a constant angle of attack, at which it will stall, regardless of speed or attitude. Also it must be remembered that acceleration in the pitching plane increases the aerodynamic wing loading and accordingly increases the stalling speed. This type of stall is commonly known as the "high speed stall". It often occurs without warning.

Demonstration 5—High Speed Stall from a Dive (Flaps UP)

Close the throttle, reduce speed to 80 m.p.h., dive until an airspeed of 110 m.p.h. is attained, then move the control column back harshly. The aircraft shudders and stalls at about 100 m.p.h. WITH THE NOSE BELOW THE HORIZON, and a wing drops. Recover as before.

Demonstration 6—High Speed Stall from a Steep Turn

Go into a steep turn, try to increase the rate of turn rapidly by harsh backward movement of the control column. The aircraft shudders, stalls and flicks. Recover as before.

From these last two demonstrations it can be seen that harsh backward movements of the control column are to be avoided (particularly near the ground) and how recovery from a stall, if too hurried, can induce another of a more violent character.

6. MEDIUM TURNS

Medium turns are carried out in a similar manner to those in elementary types.

The following minimum speeds, however, are to be observed—

No engine, Flaps Up	105 m.p.h.
No engine, Flaps Down	95 m.p.h.
15 in. Boost, Flaps Down (i.e., powered approach conditions)	90 m.p.h.

7. TAKING OFF INTO WIND

Taxy to a position which will give the longest run into wind clear of obstructions and turn the aircraft 90 degrees out of wind facing in the direction of the circuit. In this position, aircraft on the ground and in the air can be seen readily. It is also an indication to others that the aircraft is not immediately about to take off.

Do not allow the engine to idle at less than 800 r.p.m.

The take-off in this aircraft is similar to that in an elementary type aircraft, except that the tail is heavier to raise off the ground, the aircraft has a tendency to swing to the left and leaves the ground at a high speed.

Test the switches at 1500 revs. after ensuring that the cylinder head temperature is 160 degrees, and the oil temperature 60 degrees. Note the oil and fuel pressures, which should be approximately 90 and 4 lbs. per sq. in. respectively.

Now carry out the VITAL ACTIONS DRILL, which is represented by the catch phrase T M P Fuel and Flaps.

T	for Trim	Elevator trim 11 o'clock, Rudder trim 3 o'clock.
T M	M for Mixture	Mixture control right back to full "Rich" position.
T M P	P for Pitch	Pitch control fully forward to "Fine" position.
T M P	Fuel	Check that the cock is turned to "RIGHT" tank. Note the contents of both tanks and check the fuel pressure.
T M P	Fuel and Flaps	See that flaps are up and locked.

Turn into wind, look both ways for aircraft taking off or converging, lock the tailwheel and uncage the directional gyro, if required. Slide the feet off the brakes, so that heels are on the floor. Take off by opening the throttle slowly to the gate, which should give 35 inches of boost. This boost should not be exceeded.

When airborne, again check for converging aircraft, and carry out the after take-off VITAL ACTIONS DRILL, which is represented by catch phrase U M P and Flaps.

U for Undercarriage	When aircraft is airborne, raise the undercarriage
M for Mixture	Ensure that the mixture control is in the fully rich position.
P for Pitch	Throttle back to 28 in. boost, then pitch control back to 2100 r.p.m. Trim to climb at 110 m.p.h.
Flaps	If flaps have been used for take off, when at a height of 300 feet raise and lock them.

NOTE 1.—It is essential that the take-off and after take-off procedure be explained before actually taking-off, as there is very little time during this period for explanations. All that is necessary is to give a brief outline.

NOTE 2.—It is a common fault on Wirraway aircraft for one wheel to fail to lock in the up position, thus it is necessary to ensure that both wheels are retracted after carrying out the after take-off vital actions.

ENGINE FAILURE

If the engine fails soon after take-off immediately assume the correct gliding speed of 100 m.p.h., lower the flaps if time allows and land straight ahead turning if necessary to avoid any large obstructions.

Land with the undercarriage retracted. Even if the retraction is not complete the undercarriage will collapse on landing.

Under no circumstances attempt to turn back to the aerodrome.

Use of wobble pump may prove effective if fuel pressure has caused failure.

8. POWERED APPROACH AND LANDING

When approaching the aerodrome to land, check over the cockpit noting the following points—

(1) Mixture in "Rich".
(2) Carburettor heat control into "Cold" position.
(3) Sperry instruments caged (under normal day conditions).
(4) Tail wheel locked.
(5) Open sliding roof.

In the circuit reduce the speed to a maximum of 135 m.p.h. The circuit is rectangular in shape and is carried out at 1200 ft. It is larger than for the elementary type.

Before landing carry out the pre-landing vital actions drill, which is represented by the catch phrase—Fuel U M P Flaps.

When on the down wind leg.

FUEL. See that there is a minimum of 10 gallons in the tank being used.

"U" for undercarriage. Undercarriage down. This is carried

out early in the down wind leg of the circuit. The method of lowering the undercarriage is as follows—

(1) Throttle back until the warning devices are working. The red light should glow and the horn blow.
(2) Move the undercarriage selector lever to the normal "DOWN" position.
(3) Engage power valve, and watch indicators go down.
(4) When the warning devices cease to operate, the undercarriage is down and locked.
(5) Throttle on again to 26 in. boost and place the selector lever into the emergency position.
(6) Release power valve.

When a suitable distance down wind, turn across wind and continue the vital actions, after throttling back to approximately 15 in. boost.

"M" for Mixture	Ensure that the mixture control is in the fully "Rich" position.
"P" for Pitch	Move pitch control into fully "Fine" position.
FLAPS	When in a suitable position and with the speed below 115 m.p.h., lower the flaps. It is important to lock the flaps, otherwise they will be forced up by the pressure of air.

Trim to the approach speed of 85 m.p.h.

Make the approach so that the turn into wind is commenced at about 800 feet and completed before reaching 500 feet.

Control the rate of descent with the throttle and the airspeed with the elevators. If overshooting, throttle back and lower the nose. If undershooting, throttle on and raise the nose.

Continue the moderate angle of approach until safely across the leeward obstacles, and then at about 20 feet commence to ease the control column and throttle back for the landing.

After the landing the aircraft runs straight due to the locked tailwheel, and any small tendency to swing can be checked quickly with the early application of opposite rudder during the initial stages of the landing run, and later with brakes.

Towards the end of the landing run, ease the aircraft gently to a standstill with the brakes. After the aircraft has stopped unlock the tailwheel, look around to make sure all is clear, then turn 90 degrees to the wind in the direction of the circuit.

Raise and lock the flaps and adjust trim neutral for taxying.

NOTE 1.—When landing, be careful not to stall the aircraft too high otherwise a wing may drop and strike the ground. Also be careful not to move back the control column harshly otherwise the aircraft will stall abruptly and strike the ground heavily. If the wheels touch

first stop the backward movement of the control column and allow the tail to go down on its own accord.

NOTE 2.—If approach is made with an abnormal amount of throttle, then throttle back to a fast tick over on clearing the boundary.

NOTE 3.—Under strong wind conditions, and for Intermediate Training Squadron pupils it is recommended that the approach speed is increased to 90 m.p.h.

8A. BAULKED APPROACH PROCEDURE

If in the final stages of the approach it is found necessary to go round again—

(1) Open the throttle to the gate.
(2) Trim to climb at 85 m.p.h.
(3) Raise undercarriage.
(4) At 300 feet raise the flaps by degrees.*
(5) Throttle and pitch controls back to normal settings for the climb.

*See appendix C (c) for method of raising flaps.

9. GLIDING APPROACH AND LANDING

The circuit for a gliding approach is made at 1500 feet so that the turn into wind may be made at a reasonable distance back from the aerodrome and the turn completed before 500 feet. The circuit is similar to that for a powered approach and landing, but the cross wind leg is carried out closer to the aerodrome. The vital actions are completed in the normal positions.

When within easy gliding distance of the aerodrome on the cross wind leg close the throttle and complete the vital actions, assuming the correct gliding speed of 90 m.p.h.

While gliding across wind correct the approach by either gliding in towards or away from the aerodrome. Keep a sharp lookout for other aircraft underneath. Commence the turn into wind at approx. 1000 feet, increasing the speed to 95 m.p.h. for the turn.

The landing from a gliding approach is made by starting to flatten the glide slightly higher than for a normal landing, because of the large change of attitude from the glide to the landing attitude.

If overshooting after turning into wind, extra height may be lost rapidly by lowering the nose. However, speed should not be allowed to increase excessively, and the normal gliding approach attitude should be resumed in ample time to commence the landing.

10. SPINNING

The spin in this type of aircraft is similar to that of an elementary type. The control movements for recovery, however, must be more positive, that is FULL opposite rudder and THEN control column forward until the spin stops.

Before spinning the following precautions must be taken—

(1) The spin is to be started at a minimum height of 8000 feet. Recovery must be effected before reaching 4000 feet.
(2) Cage sperry instruments and turn off the vacuum pump at least 6 mins. before spinning.
(3) Lower the undercarriage. This prevents the warning devices from working while the engine is throttled back and also reduces the speed in the dive after the recovery.
(4) Check that the mixture is fully "RICH".
(5) Open the sliding roof.
(6) Ensure that there is at least 10 gals. of fuel in the tank being used.
(7) Check safety harness.
(8) Carry out a 360 degrees turn to ensure that all is clear, particularly below.
(9) Throttle back to about 15 in. boost and bring the pitch control back to the full course position to prevent excessive engine speed in the dive.

Now throttle back and stall the aircraft; just before the point of stall apply full rudder in the desired direction. The control column is brought right back as the aeroplane goes into the spin.

To recover apply full opposite rudder, and then ease the control column progressively forward until the aeroplane stops spinning. When the spinning stops centralise the rudder and ease out of the dive. When the nose reaches the horizon and speed decreases, place the pitch control half way forward and open the throttle to cruising boost. Finally adjust to correct r.p.m. and boost.

Retract the undercarriage, close the cockpit and adjust mixture as necessary.

INCIPIENT SPIN

The incipient spin is demonstrated from—

(1) Gliding turn (flaps up).
(2) Steep turn with engine.

Gliding Turn.

Go into the turn at a slow speed of approximately 75 m.p.h. and holding off the bank, increase the rate of turn with excessive rudder. The nose will drop and any attempt to keep it up by backward movement of the control column will cause the aeroplane to stall and spin.

Recover promptly as before.

Steep Turn.

Go into the turn in the normal manner but with insufficient power, approximately 20 in. of boost, increasing the rate of turn by easing the control column right back. The aircraft shudders, stalls and commences to spin in the direction of yaw. Recover promptly as before.

Note that in both cases the spin was caused by misuse of controls. Should recovery be made with the aircraft in the inverted position, no attempt should be made to dive out; gather speed and recover by rolling out.

NOTE 1.—Ease the aeroplane gently out of the dive after a spin, otherwise a high speed stall may result.

NOTE 2.—It is characteristic of the Wirraway that the application of opposite controls causes the rotation of the spin momentarily to increase before becoming effective.

11. SOLO

This is carried out ONLY from the front seat; the precautions as mentioned in para. 1A must be carried out.

12. SIDESLIPPING

The Wirraway may be sideslipped effectively without flaps, up to an angle of bank of approx. 25 degrees. Any further increase in the angle of bank causes the airspeed and rate of descent to increase considerably and direction becomes impossible to maintain.

With flaps lowered, a gentle sideslip is possible but the airspeed and direction of slip are very difficult to control. Some height may be lost satisfactorily if a slipping turn is employed.

13. PRECAUTIONARY LANDING

The object of precautionary landings is to eliminate the "float" or hold-off period, thus enabling a landing to be made in a restricted space. Such a landing may be necessary when forced to land away from a recognised aerodrome for any of the following reasons—

(1) Shortage of fuel.
(2) Approaching darkness.
(3) Lost.
(4) Bad weather.

In any of the first three cases, it will probably be possible to make a circuit at a normal height. Having selected a suitable field, lower 25 deg. of flap and carry out at least one dummy run across the field into wind at an airspeed of 110 m.p.h. to choose a landing path, check the wind direction, the height of the obstructions over which the approach is to be made and the suitability of the surface.

Raise the flaps and climb away to the correct circuit height. Make a normal circuit and carry out the vital actions in the correct positions. The down wind leg must be made slightly longer than usual to give a correspondingly longer into wind leg, enabling the speed to be reduced and the aircraft to be placed almost in the landing attitude.

After turning into wind, descend to a height of 250 ft. and reduce speed to 75 m.p.h. by raising the nose. In order to maintain a constant

angle of descent it will be necessary to throttle back while speed is being reduced. Immediately the reduced airspeed has been reached the throttle MUST be opened to a minimum of 15 in. boost.

CARE MUST BE EXERCISED THAT THE THRUST IS NOT REDUCED TOO MUCH AT THIS LOW SPEED, as the effect of this is to increase the stalling speed.

When very close to the ground ease back the control column and throttle gently, being careful not to close the throttle fully until the aircraft is about to land.

After landing use brakes to shorten the run as necessary.

Only minor corrections for undershooting, overshooting and for drift should be made after reducing the airspeed.

NOTE 1.—In order to teach pupils this type of landing in a confined space, the instructor should indicate a mark on which he intends to land.

NOTE 2.—When practising precautionary landings do not use the brakes excessively.

NOTE 3.—Under strong wind conditions and for Intermediate Training Squadron pupils, the speed should be reduced only to 80 m.p.h.

Bad Weather.

If forced to land due to bad weather and visibility is such that the view of the field would be lost during the circuit, the gyro should be set to zero on the dummy run. After completing the dummy run, turn gently at rate 1 on to 180 degrees. Fly a suitable distance down wind and then turn in the same direction at the same rate on to zero. The aircraft will then be heading towards the field and within easy reach of the landing path.

Make the circuit as high as possible (for practice assume 500 ft.). Carry out vital actions in the correct positions with the exception that the remainder of the flaps are lowered when into wind. If more height is available then they could be lowered across wind.

14. LOW FLYING

Practice low flying is carried out over the prescribed area with the instructor only.

Before starting and during the exercise the fuel contents should be checked.

Low flying consists of two types—operational low flying and low flying due to bad weather (precautionary).

Operational Low Flying consists of flying close to the ground at high speed, taking advantage of any natural cover which the surrounding country might afford.

Precautionary Low Flying: If forced to fly close to the ground due to low cloud or bad visibility it is desirable to fly as slowly as possible

in order to keep a better check of position and to allow more time to avoid obstructions. A reasonable slow speed for this type is 110 m.p.h.

If the engine is throttled back to obtain this speed and level flight is maintained—

(1) Vibration is caused.
(2) There is a loss of control on the rudder and elevators due to a reduction of slipstream over them.
(3) The nose is raised, restricting the view ahead.
(4) A feeling of instability is apparent.

To overcome these conditions, lower the flaps to 25 degrees. This increases the lift, decreases the stalling speed and also introduces a certain amount of drag.

It will now be necessary to open the throttle to maintain level flight at 110 m.p.h. Set the pitch to 2100 r.p.m.

The result is—

(1) The engine runs more efficiently and there is no vibration.
(2) Rudder and elevator control is improved.
(3) The nose is lowered, improving the view ahead.
(4) There is greater safety and feeling of stability.

Low flying under these conditions should be practised at 200 to 400 ft. and only when an instructor is present.

It is advisable to do only medium turns, the throttle being opened to 28 in. to overcome the extra loading.

In all low flying the following errors should be avoided—

(1) Don't be misled by false horizons formed by surrounding hills or broken country.
(2) Do not misjudge the radius of the turn which is much greater in this type of aircraft than in elementary types.
(3) Don't be misled by the apparent slip or skid when turning from into wind to down wind, or from down wind to into wind respectively.
(4) Avoid using too much rudder and holding off excessive bank in turns.

NOTE.—In demonstrating this sequence it is essential that level flight be maintained.

15. STEEP TURNS

WITH ENGINE

To go into the turn open the throttle to 28 in. of boost. The controls are moved in the same way as for a turn in an elementary type. Do not overbank and do not ease the control column back too harshly, otherwise a high speed stall might result. In the turn the speed is approximately 135 m.p.h. and the vertical speed should remain at zero.

WITHOUT ENGINE

With flaps up increase speed to 110 m.p.h. With flaps down increase speed to 100 m.p.h. to allow for the extra loading in the turn. Again care must be taken not to ease the control column back too harshly.

16. CLIMBING TURNS

From the straight and level position, the correct climbing attitude is first assumed. To commence the turn, do not increase the power, but lower the nose slightly to increase the speed to 115 m.p.h. to allow for the extra loading in the turn. Go into the turn in the normal manner, turning at approximately rate 1 and employing no more than 20 degrees bank.

Note the position of the nose and the wing-tips in relation to the horizon.

Recover normally.

17. FORCED LANDING

The principle of a forced landing in this type of aircraft is similar to that on an elementary type. The object of the approach is to glide to a position at 1500 feet on the leeward side of the field, from where an ordinary gliding approach can be made.

Practice forced landings should normally be demonstrated from a height of at least 4000 feet as it is at this height or above at which flying is mostly carried out away from the aerodrome.

The points of difference between this and an elementary approach are—

(1) The nose need not be lowered immediately the engine fails. Height can be maintained before gliding speed of 110 m.p.h. is reached.
(2) A larger field is required, and in this respect it is better to take a long run even if it is slightly out of wind, rather than a short run into wind.
(3) A decision has to be made whether to land with the undercarriage up or down, depending on the size and surface of the field. It is better to land with the undercarriage retracted if the selected field is small or the terrain is unsuitable.

In the event of engine failure, assume the correct gliding speed of 100 m.p.h. and trim. Choose a field for the landing and glide to the down wind side of it by the shortest route which will allow the field to be kept in sight the whole time. Whilst gliding to the down wind side, try to locate the cause of failure. It is most likely that the fuel tank which is being used is empty or the mixture control is open too far. If the

cause is not found, close the throttle and carry out cockpit check as follows—

Mixture to rich.
Pitch to fine, and
Sliding canopy open.

When on the down wind side of the field, lose height by gliding across wind making a turn or turns when necessary in order to keep within easy gliding distance. All turns must be made towards the field, for two reasons, first to keep the field in view and, secondly, to counteract the effect of drift.

Aim to place the aircraft in such a position at 1500 feet that a normal gliding approach can be made.

At a height of between 2500 feet and 2000 feet, decide whether to lower the undercarriage, bearing in mind that it must be lowered manually if the airscrew has ceased to windmill. Now on the last cross wind glide (at a height of between 1500 and 1000 feet) when within easy flapped gliding distance, lower the flaps. If tending to undershoot, edge towards the field and if tending to overshoot, edge away from the field. Tend to land well into the field and when quite certain of getting in, lower the nose and lose excess height (see Gliding Approach). Immediately prior to landing, switch off the ignition and turn off petrol cock.

NOTE 1.—During practice forced landings, the throttle should be opened up sufficiently to prevent severe popping, which should be overcome at about 1400 revs. It also helps to maintain cylinder head temperature.

NOTE 2.—It is imperative that the precise field as soon as it has been selected, is indicated to the pupil, also the direction in which the landing is to be made, in order that he may fully understand the planning of the approach.

NOTE 3.—In very cold weather conditions, place the carburettor heat control in to the "hot" position during the descent. In a practice forced landing when it is not intended to land, it must be placed in the "cold" position immediately after opening the throttle.

NOTE 4.—It is essential that the engine is warmed up at every 1000 feet of descent. Do this by opening the throttle until 20 in. of boost is indicated, throttling back as soon as this has been attained.

18. ACTION IN THE EVENT OF FIRE

1. Turn off petrol.
2. Open throttle fully to use up petrol in carburettor and pipe-lines.
3. Switch off after engine has ceased firing.
4. Operate fire extinguisher.
5. If the fire becomes serious, head the aircraft towards open

country, trim for the glide and abandon the aircraft. The sliding hood should not be opened until immediately before leaving the aircraft, otherwise flames and smoke will be drawn into the cockpit.

NOTE.—The fire extinguisher is situated on a panel on the port side of the rear cockpit. It is hand operated and has no connection to the engine. It is accessible from the outside of the aeroplane by releasing and pulling out the panel to which it is fitted.

18A. ABANDONING AIRCRAFT

If time permits, the following procedure should be adopted—

(1) Use up as much petrol as possible.
(2) Order passenger to abandon aircraft.
(3) Open sliding cockpit enclosure.
(4) Disconnect communication tubes and undo safety belt.
(5) Head the aircraft towards open country.
(6) Turn off petrol and switches, close the throttle and trim for normal glide.
(7) Holding the rip cord ring in the right hand, slide over the side head foremost facing the tail. Do not stand on the seat facing forward as injury to the back may result.
(8) Make no attempt to pull the rip cord until well clear of aircraft.

In an emergency, if the aircraft is travelling at a high speed, it may be impossible to open the sliding canopy owing to the air pressure, in which case the side panels should be released by pulling on the handles situated on frame of the canopy.

To abandon the aircraft in a spin, a dive towards the inside of the spin should be made.

20. TAKING OFF AND LANDING OUT OF WIND

If a take off or landing has to be made on a long and narrow landing ground, or on a runway, with the wind blowing across it, it will be executed as follows—

TAKE OFF

In other than abnormal conditions of drift, the Wirraway may be taken off cross wind successfully in the normal manner, but with the stick held over to the side of the cockpit from which the wind is blowing. In strong wind conditions, it may be necessary to edge down wind to reduce strain on the undercarriage. As soon as full flying speed has been attained, the aircraft should be turned into wind.

APPROACH AND LANDING

Commence a normal approach and having made all preparations for landing, including the drill of Vital Actions, turn in for the final leg with the aeroplane heading sufficiently into wind to counteract the effect of drift. As the landing path is approached, swing the nose back

to face the line of landing and counteract drift by sideslipping into wind (instead of by pointing the aeroplane into wind as before). As holding-off is commenced, and speed is lost, level the aircraft laterally and make a normal landing. After touching down the tendency to weathercock into wind will be checked to some extend by the tailwheel lock it should be resisted by the use of rudder and brake, whilst assistance will also be given by holding the control column over to the side from which the wind is blowing. Once the aircraft is firmly down on three points any tendency for it to be heeled over by the effect of wind can be counteracted by edging gently down wind, and thus creating a slight lurch in the direction from which the wind is blowing.

20A. NIGHT FLYING

The Wirraway has no unusual characteristics which make it difficult to fly at night. Landing may be assisted by use of headlights.

Before flying at night, it is essential that the position and operation of all switches and flare releases be thoroughly understood.

Test directional gyro and artificial horizon before night flying.

The following procedure is to be carried out—

(1) Run up the engine for five minutes with the vacuum pump on and the suction gauge showing 3½ in. Hg. If suction gauge is not fitted, run the engine at 1500 revs. for the same period.

(2) Ensure instruments are working correctly by turning the aircraft fairly quickly through 90 degrees on level ground. The directional gyro should come to rest at the same time as the turn is completed, and the model aeroplane in the artificial horizon should remain parallel to the bar throughout the turn.

Should the directional gyro continue to turn after the aircraft has completed its turn, or the model aeroplane take on bank, it may be assumed that these instruments are not working correctly.

NOTE 1.—Undercarriage should be lowered as soon as possible after turning down wind and before permission to land is requested.

NOTE 2.—Pupils should be given at least three instrument take offs during the day preceding their first night flying.

NOTE 3.—The directional gyro should be used to ensure correct circuit.

20B. FORMATION FLYING

The general principles on which formation flying training should be based are comprehensively laid out in A.P. 129. F.T.M. Part 1.

Formation practice should invariably be preceded by ground instruction. It is essential that members of a formation have a clear understanding of what is to be attempted in the air, and know exactly what signals are to be used. The correct stations and intervals between

aircraft should be shown on the ground before take off. Station keeping is achieved by the use of all three controls in conjunction with a busy throttle.

To keep station—

(1) Always keep the mainplanes parallel with those of the leader, i.e., keep bank constant with the leader.

(2) Use rudder to yaw in towards or away from the leader, so as to keep the correct distance.

(3) Keep a busy throttle to maintain position.

(4) Keep on the same level as the leader by combined use of elevators and throttle.

Formation flying in Wirraway aircraft is quite easy, but the following main points should be brought out—

(1) Acceleration of this type of aircraft is fairly rapid but deceleration is slow.

(2) Movements of the leader must be anticipated but not unduly so.

(3) Under no circumstances lose sight of the leader by getting too far above or below him. Keep him in full sight all the time.

(4) Having obtained the straight and level settings the constant speed airscrew makes no difference to the operation of the throttle in keeping station.

SIGNALS TO BE USED

OPEN OUT: Rock the aircraft fore and aft.

CLOSE UP: Rock the aircraft from side to side.

ECHELON RIGHT: Right forearm raised with clenched fist.

REFORM VIC: Repeat same signal.

TURN RIGHT: Raise right forearm with hand in front of the face, then move it across to the right.

TURN LEFT: Same with left forearm.

COME OUT OF TURN: Forearm raised with hand open and at right angles to face, move forward to the crash pad.

LINE ABREAST: Both hands open at shoulder height pushed forward simultaneously.

REFORM VIC: Both hands open at shoulder height pulled backwards simultaneously.

CHANGING STATION: Form Echelon and then wave the next man forward to take the lead.

21. RESTARTING ENGINE IN FLIGHT

It is very difficult to stop the airscrew windmilling whilst the Wirraway is in flight. If it does stop restart by pressing the starter button.

22. AEROBATICS

The following precautions must be observed before commencing aerobatics—

(1) Sperry instruments caged, and vacuum pump turned off six minutes before commencing aerobatics.
(2) Gain sufficient height so that at no time during the aerobatics will the aircraft come below 4000 feet.
(3) Check safety belts for security and tension.
(4) See that there is a minimum of ten gallons in the tank being used.
(5) Open the sliding roof.
(6) Set the boost to 25 in., and the revs. to 2000 (these remain unaltered throughout the aerobatics).
(7) Do a 360 degrees turn to ensure that all is clear.

(a) LOOP

Gain speed to 200 m.p.h. and ease the aircraft gently out of the dive. As the nose comes above the horizon increase the backward pressure on the control column. When the aircraft passes the vertical stop the backward movement and allow the aircraft to fly itself around the top of the loop, keep straight with rudder.

Do not pull the control column back on top of the loop otherwise a high speed stall will result, and the aircraft will do what looks like a bad half roll off the top.

Ease the aircraft gently out of the resulting dive. Any harsh movement of the control column may result in a high speed stall.

(b) STALL TURNS

Gain speed to 160 m.p.h., ease the control column gently back until the aircraft is climbing at approximately 80 degrees, and as the airspeed approaches the 100 m.p.h. mark, gently ease on full rudder in the required direction. As the nose points towards the ground centralise the rudder, level the aircraft with aileron, and ease out of the resultant dive.

(c) SLOW ROLL

Gain speed to 160 m.p.h. (minimum), ease the nose about a foot above the horizon and roll in the normal manner. In the roll opposite rudder must be held on while the aircraft is inverted to keep it straight, and the control column must be held firmly forward to keep the nose up.

Recovering from the roll, firm top rudder is necessary to prevent the nose dropping, and the control column must be moved firmly back, also to prevent the nose dropping. When the aircraft is level centralise the controls. Little or no height will be lost in a good slow roll.

(d) HALF ROLL OFF TOP OF LOOP

Gain speed to 220 m.p.h. and gently ease the aircraft out of the dive. Continue the backward movement of the control column until the aircraft is over the vertical then throw back the head and watch for the horizon to appear. As the nose approaches within about three feet of the horizon commence the roll by applying full aileron in the desired direction and sufficient rudder in the same direction to overcome keel surface effect and aileron drag. As the aircraft rolls on to its side and the nose comes down to the horizon, ease the control column forward and as it approaches the level position centralise the controls.

Appendix A—PETROL SYSTEM

Wasp S1. H1. G. Engine

1. GENERAL

The correct aviation fuel to be used in Wirraway aircraft is 91 octane, but where 91 octane fuel is not available, an alternative of 87 or 100 octane fuel may be used providing it is unleaded commercial motor fuel.

2. TANK CAPACITIES

A tank is installed in each side of the centre section. These tanks provide for a total capacity of 92 gallons, the right hand tank holding 46 imperial gallons, and the left tank, which is divided into main and auxiliary, holds 30 gallons and 16 gallons respectively. The total capacity of the left hand tank is available when the three-way cock is switched to "Reserve".

3. FUEL SYSTEM

The port and starboard tanks are not directly connected together, but both tanks operate through a three-way cock, for the operation of which controls are fitted to both front and rear cockpits. These cocks are capable of switching from one tank to another, and then to reserve, so as to give maximum continuous operation.

A Romec type engine driven fuel pump is located on the engine and draws fuel from the tanks. The fuel is drawn from the tanks through the three-way cock to a relief valve and filter, thence through the pump to the carburettor.

An auxiliary hand pump is fitted into the system. It is used to apply fuel pressure to the carburettor before starting, and in the event of engine driven pump failure may be used to provide emergency supply of fuel to the carburettor.

4. GAUGES

The fuel level in each tank is indicated by a float type gauge, one being situated on each side of the fuselage in the front cockpit. They are visible from both cockpits.

Appendix B—OIL SYSTEM

1. GENERAL

The oil to be used in Wasp engines S1. H1.G. is D.T.D. specification 109, first grade aviation oil of the 120 oil seconds, however, if this oil is not available an alternative aviation oil of first grade may be used provided it is 100 oil seconds.

2. OIL TANK

The capacity of the oil tank is 8½ gallons, but care must be taken never to fill the tank to more than 7¾ gallons, this is to allow ample breathing space in the top of the tank.

Appendix C—OPERATION OF FLAPS

(a) TO SET THE FLAPS FULLY UP OR DOWN

Move the selector lever to the required position "up" or "down".

Engage the hydraulic power valve.

The flap indicator will be seen to move towards the selected degree of flap angle. When the operation is complete, the hydraulic warning light will glow and full pressure will be registered on the pressure gauge.

Release pressure by disengaging the power valve.

Lock flaps by moving the selector to the central position.

The flaps MUST BE locked after every operation.

(b) SETTING FLAPS TO ANY DESIRED INTERMEDIATE ANGLE

Select flaps "down".

Operate hydraulic power valve.

Transfer the hand quickly to the selector lever and when the flaps indicator shows the desired angle pull the lever quickly to the locked position.

Release power valve.

This operation can be carried out from the front cockpit only.

(c) RAISING FLAPS AFTER A BAULKED APPROACH

Move the selector lever back gently until a resistance is felt.

Move it quickly into this resistance and out again. The flaps will be forced by the airflow towards the retracted position.

By repeating the latter movement the flaps can be retracted gradually and without loss of height.

The hydraulic power should not be used until the last 10 deg. is reached.

Appendix D—TAKING OFF AND LANDING WITH VARYING DEGREE OF FLAP

(a) TAKING OFF

The Wirraway will take off quite comfortably with any degree of flap, including full flap.

The optimum lift/drag ratio flap setting is 15 degrees and this provides the shortest run and maximum climb to clear obstructions.

The take off is done in the normal manner, the aircraft becoming airborne and climbing at a lower speed. The best climbing speed under these conditions is 100 m.p.h.

TAKING OFF FROM A RESTRICTED SPACE

Set the flaps to 15 degrees.

Head along the take off path and with firm brake pressure applied, open the throttle to 35 in. boost (or 38 in. if necessary).

Prevent the tail from rising. Release brake pressure evenly and quickly and take off in the normal manner, being careful not to raise the tail too high.

NOTE.—When setting the flaps for the take off, the hydraulic pressure need not be used. For 15 degrees set 20 degrees on the indicator and air pressure will force the flaps back to the correct 15 degrees.

(b) LANDING

In a powered approach with the flaps up height is lost slowly and the nose is sufficiently high to restrict the view ahead. The stalling speed is higher than with the flaps down.

When making an approach to land with flaps up allowance must be made for the slow loss of height by making the final cross wind leg further away from the aerodrome.

Owing to the reduced view ahead, care must be taken to ensure that the path of the approach is clear.

The landing is carried out in the normal manner but it should be noted that the angle moved through from the gliding attitude is smaller than with the flaps lowered, the hold off is longer, the landing speed is higher and landing run longer. Therefore care must be taken not to overshoot, and if any doubt exists about getting into the aerodrome another circuit must be made.

The approach speed with flaps up is 100 m.p.h. gradually reducing to 85 as the boundary is reached.

When landing in a strong wind the flap setting may be reduced up to 30 degrees, depending on the strength of the wind. If full flap is used during the approach to land in a strong wind, an abnormal amount of power must be employed to maintain the usual angle of descent.

Appendix E—THE EXHAUST GAS ANALYSER

The mixture control and exhaust gas analyser are used in conjunction with each other in order to operate the engine at the correct mixture and to maintain the correct cylinder head temperature.

When the instrument is switched on (by turning the carburettor air temperature switch to No. 1 position), the pointer will swing towards the rich end of the scale and then, if properly adjusted, will swing back slowly and indicate the correct fuel-air ratio of .078. As the aircraft ascends, the pointer will swing to the rich end of the scale. At 5000 feet, the mixture control must be opened to bring the pointer back to the correct ratio of .078 and also to keep the cylinder head temperature up to operational figures. As height is gained above 5000 feet the mixture must be progressively weakened to maintain the correct fuel-air ratio.

When leaning the mixture, by opening the mixture control, the cylinder head temperature should be watched to guard against overheating of the engine. If the mixture becomes too lean and detonation occurs, the pointer of the instrument will move erratically, generally towards the rich end of the scale. The mixture control should be closed slightly to richen the mixture and remove this condition which is very harmful to the engine.

To facilitate adjustments to the correct mixture for various power outputs, a scale of manifold pressure is incorporated indicating the correct mixture for a particular boost setting. The readings are those used under operational conditions.

Owing to a five or six seconds lag in the recordings of the instrument, the mixture control should be moved forward with caution.

A mechanical guide to the correct mixture strength is obtained by placing the front edge of the mixture lever in line with the rear edge of the throttle lever. With this setting the mixture will be almost correct. It will be slightly rich, which is desirable when operated in this manner.

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