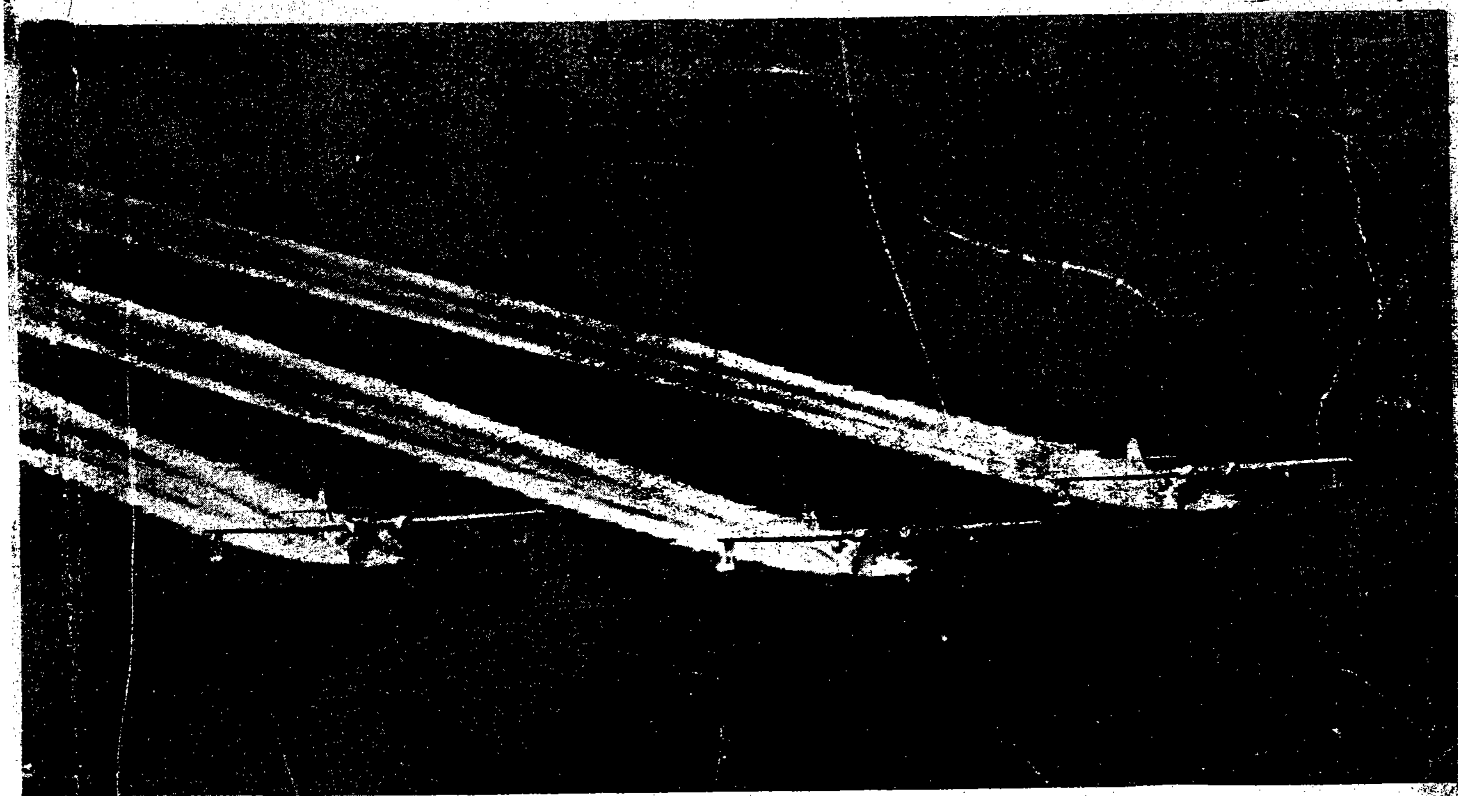
APPENDIX "B"

CANSO FLYING MANUAL



ISSUED ON THE AUTHORITY OF THE AIR OFFICER COMMANDING

TRAINING COMMAND

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PREFACE

The purpose of this manual is to present a basis for the instruction of uniform flying boat handling techniques with particular reference to the Canso aircraft.

For technical detail, EO 05-1-1 (Pilot's Operating Instructions) and other publications should be consulted; this manual does not supersede such specifically technical publications, it complements them.

Suggestions for additions or amendments are invited and should be forwarded to Training Command Headquarters, on the enclosed form, at the earliest opportunity.

March 1959

AMENDMENT CHECK SHEET

The undermentioned amendments promulgated for this publication have been entered as indicated below:

Amendment List		Amendments Made By	Date
Number	Date		

INTRODUCTION

The methods and techniques presented in this manual are not necessarily the only, or even the best ones, but they are safe and effective having been evolved over many years' experience. It is recommended that the novice learn and become proficient in these before experimenting in new methods.

Taking off and alighting on water involves coming in contact with it or travelling along its surface, at speeds ranging from zero to eighty knots. It should be kept in mind that water travelling at high speeds is used to strip bark from huge logs and to cut into the sides of mountains, removing tons of earth and rock during mining operations. This same water pressure can strip the skin from the hull of a Canso in an instant, if given the opportunity.

Therefore, an elementary knowledge of the basic laws of physics and mechanics is not only helpful, but essential in understanding the principles of water flying.

TABLE OF CONTENTS

TABLE OF CONTENTS (Cont'd)

CHAPTER 1

LAND FLYING

1.01 PRE-FLIGHT CHECKS

(1) It cannot be too strongly stressed that poor pre-flight inspection of aircraft has been responsible for many aircraft accidents. Detailed external and internal check lists have been laid down in pilot's handling notes and in the Canso Aircraft Training Manual; these should be carefully followed.

(2) Further, flying boats and seaplanes are more exposed to hull damage, the corrosive effect of salt water, and other hazards not usual in landplane operation. Therefore, extra care should be taken in pre-flight inspection of seaplanes and flying boats to ensure the most efficient and safe operation.

(3) In the past Canso aircraft have sunk on take-off owing to the omission of a very elementary external check. This happening, if survived by the pilot, could have a very serious effect on his career. Missing rivets, loose nose wheel doors, unlocked hatches, open ventilators are only a few of the many small things which seriously affect the safety of a Canso aircraft. Close attention to check lists devised by experienced pilots can go a long way towards eliminating needless accidents.

1.02 STARTING AND RUN-UP

(1) The pilot has only switches and throttles to handle; the gas cocks, strainer drains, crossfeed switches, booster coils, energizing and meshing mechanisms are handled by the flight engineer. Therefore, unless starting drills are handled professionally, according to check lists, a large margin of error may develop. Strict adherence to proper procedure and a good understanding by the pilot and flight engineer of the other's function is essential. Nothing is more disconcerting to a pilot than to see his engines starting before he is properly seated, or to an engineer who cannot get an engine started because of his pilot's incompetence at throttle handling.

(2) Complete competence in the pilot and flight engineer is essential, and close co-operation between them, even during the simple operation of starting, ensures their readiness to deal with an actual emergency such as engine failure or fire in the air.

1.03 TAXIING

(1) Taxiing a Canso on land is a simple operation. Since the engines are close together, differential throttle is not as effective as in most twin engine aircraft. Rudder effect is negligible and consequently it is best to taxi with the rudder in the locked position. During windy conditions it is dangerous to taxi with the rudder in the unlocked position because of its size and the fact that it is almost impossible to hold and, at the same time, operate the brakes properly. The brakes are powerful and sensitive, making it an easy matter to taxi in a straight line with only the barest touches of brakes to keep the aircraft straight. Another reason for keeping the rudder locked while taxiing is that, because of the large rudder travel, it is often difficult to apply brake effectively or evenly in the full left or right rudder position, and even more difficult to apply full brake in the intermediate positions. The brakes should be tested immediately the aircraft begins to move. The time to discover brake unserviceability is on the line.

1.04 TAKING OFF

(1) Needless to say, the vital actions drill is the most important part of the take-off sequence. These should be known by heart since on water it is not always possible to use a check list.

(2) The Canso is equipped with a tricycle undercarriage and consequently is not subject to ground looping tendencies. This is due to the fact that deceleration forces acting on the main wheels are behind the centre of gravity, tending to straighten the aircraft out. To assist this tendency and also to reduce wear and tear on the nose wheel, the nose wheel should be lifted as soon as possible during take off.

(3) The aircraft is taxied onto the runway and forward a few feet to straighten out the nose wheel. The throttles are then opened smoothly to 48" MP and the feet moved down off the brakes. The aircraft is kept straight during take-off with rudder alone. The nose wheel is then immediately lifted a few inches off the runway. The aircraft is now in a flying attitude and takes off when it attains the necessary flying speed (60K to 70K depending on load). This attitude should be maintained until the aircraft is well off the ground, at which time the wheels are raised. The speed increases rapidly without levelling off, and at 85k to 90k the power is brought back to normal climb (35" MP and 2300 rpm).

(4) The undercarriage lever is operated by the pilot by simultaneously pulling out the lock with thumb and forefinger and turning the lever slightly with the other fingers. The lock can then be released, and the lever turned fully clockwise, using the whole hand. A tendency among student pilots to lean forward against the control yoke while performing this operation should be checked since it results in the aircraft swooping towards the ground.

1.05 ENGINE FAILURE ON TAKE-OFF

(1) If an engine fails immediately after the aircraft becomes airborne, it is necessary to land straight ahead. Since a Canso usually becomes airborne in less than 2,000 feet, the remainder of the average 5,000 foot runway should offer sufficient clearance to land. Harsh braking is necessary; in this it should be remembered that repeated applications of brake are more effective than locking the wheels with the first application.

(2) The safety speed (the speed at which the aircraft can be held straight with one engine feathered and the live engine at full power) is 80 k to 85 k. Therefore, if the aircraft has attained this speed it should be possible to maintain height and even climb on one engine. 85 k to 90 k allows a larger margin of safety, but it is not always possible to maintain this speed. It has been found that a Canso can be kept straight, and maintain height, at 75 k with one engine feathered and the other at full power provided that the aircraft is trimmed properly and flown smoothly.

(3) 90 k is the recommended single engine speed, but rather than lose height steadily at 90 k on one engine, speed should be reduced to 80 k or even 75 k in order to maintain height. Then, if necessary, additional speed can be gained by putting down the nose. As a general rule, 80 k is a safe speed for all normal single engine manoeuvres, although speeds as low as 75 k are acceptable in certain circumstances.

1.06 CLIMBING

(1) The most efficient speed is 85 k to 90 k although the aircraft can climb at lower speeds. At speeds below 85 k the aircraft mushes slightly and the rate of climb is reduced. Also, cylinder head temperatures tend to build up. Individual Cansos have different characteristics and it is often necessary to experiment with each one at speeds between 85 k and 90 k to find its best climbing speed.

1.07 STRAIGHT AND LEVEL FLIGHT - TURNING

(1) The Canso, having a tendency towards instability, requires constant movement of the controls, particularly of the rudders, to maintain straight and level flight. For example, banking the aircraft slightly to the right, with the feet off the rudders, causes the aircraft to swing to the left owing to aileron drag: it is nearly impossible to fly in a straight line without using the rudder. In straight and level flight the wings should be kept level and the heading held with rudder.

(2) Similarly, to turn properly it is necessary to lead with rudder on the initial bank in order to keep the ball in the centre. Once the turn is initiated, less rudder is necessary. During the turn the bank is kept constant with ailerons, and the ball kept in the middle with rudder. If the bank is kept constant throughout the turn, it is easy to maintain a good turn with judicious use of the rudder.

1.08 DESCENDING

(1) Letting down in a Canso is similar to letting down in other types of piston engine aircraft. Experiment will show the best throttle setting for any particular desired descent; generally, 15" to 20" MP is recommended. Approximately 12" is desirable for an approach at 90 k at 500 fpm. Care should be taken to avoid carburettor icing on a long descent.

1.09 APPROACH AND LANDING

(1) Since the Canso stalling speed ranges from 58 k to 67 k (depending on all-up weight), 80 k is considered to be the critical speed for single engine, with full power applied. Providing conditions are right, and the aircraft is flown smoothly, the Canso can be flown at speeds as low as 75 k with full power on one engine only. With normal rated climbing power (35" MP and 2300 rpm) good control can be maintained at 75 k although the aircraft is sluggish and does not perform nearly as well as at 80 k or more.

(2) Despite the foregoing, it has been found by experience that the best approach speed for land or water on a normal length runway (5,000 feet) is 90 k. This allows for the throttles to be completely closed on rounding out over the button, giving considerable floating action with plenty of time to adjust for a smooth landing. Response to the controls at this speed is positive with no mush effect. Good landings can be done at lower approach speeds, but the pilot must be prepared for a certain amount of mush which makes a smooth landing more difficult to achieve.

(3) Since the Canso is not equipped with flaps, care must be taken not to make too high an approach. On short runways this could be hazardous.

(4) It should be noted also that this aircraft lands in a flying attitude and consequently has very little or no braking effect, unlike the Dakota or Lancaster where a combination of flaps and tail-down position assists in stopping the aircraft.

1.10 PRECAUTIONARY OR SHORT FIELD LANDINGS

(1) Landings on runways of 2,500 feet or less would be difficult at the above approach speeds. In a precautionary landing the approach should be made as low as possible with plenty of power. As the button is approached the speed should be reduced to 75 k. By the time the aircraft comes over the button the speed should be 70 k, with plenty of power. The power should be cut immediately the button is crossed, and the aircraft drops.

(2) If the aircraft is heavily loaded, 75 k should be the minimum speed. Considerable braking action is necessary to stop in less than 2,000 feet.

1.11 SINGLE ENGINE (SE) PROCEDURE

(1) Since the flight engineer operates such controls as the fuel and mixture controls, carburettor heat and gills, it is vital that the pilot have good communication with him and also that he be familiar with SE procedure. Appendix "B" gives a complete drill for actual or simulated engine failure. In brief the following sequence is recommended for an engine failure:

(a) Control aircraft (trim, height, direction, safety speed).

(b) Mixture (signal AUTO-RICH).

(c) Pitch 2,300 rpm to 2,550 rpm depending on load.

(d) Throttles - 35" MP to 41" MP as required.

(e) Trim, cockpit check (with flight engineer) drag check (wheels, floats).

(f) Throttle and pitch back on dead engine.

(g) Feather dead engine.

(h) Cockpit check with flight engineer (mixture idle cut-off), gills closed, fire extinguisher selected).

(2) There is a definite reason for throttling back the dead engine and pulling back the pitch control. On Canso aircraft the feathering buttons are so close together and the rudder trim is so powerful that it is possible to make a mistake as to which engine has failed. If, after both throttles and pitch levers have been advanced, the pilot pulls off the throttle on the live engine by mistake, he soon realizes his mistake and corrects it.

(3) The safety speed, as already indicated, is 80 k. A Canso can be flown quite safely at this speed and perform normal turns in either direction.

(4) It should also be pointed out that since the Canso is amphibious it is important that the wheels should not be lowered over water until the pilot is sure he can make the airfield. A wheels-up landing on an airfield is not particularly dangerous, but a landing on water with the wheels down is certain to be fatal.

1.12 NIGHT FLYING

(1) No particular problems arise in night flying except that a pilot should not level off to gain speed immediately after take-off. A shallow climbing angle should be maintained, allowing the speed to build up. Attempting to level off immediately after take-off may result in the aircraft coming in contact with the runway with the wheels partially retracted.

(2) The lighting system in the cockpit leaves much to be desired, but it is adequate provided that it is used properly. Night vision may be improved by turning out the intercom signal lights with prior warning to the engineer.

1.13 MISCELLANEOUS HINTS ON GENERAL FLYING

(1) As a rule, 80 gallons per hour is the average fuel consumption for a normal flight, including take-off and climb. This figure was arrived at by actual fuel consumption figures on northern operations.

(2) The automatic pilot can be used to conserve the pilot's energy on long flights especially when he has difficult water landings to negotiate at the end of them. The automatic pilot should be constantly monitored and should not be used under 1,000 feet. Instructions for bleeding the automatic pilot are contained in Canso Aircrew Training Manual Section 1E-6.

(3) To set up the automatic pilot in flight, the following procedure should be followed:

(a) Aircraft trimmed for straight and level flight.

(b) All indices are to be lined up with the rudder, aileron and elevator control knobs.

(c) Speed control must be adjusted (3 for rough air and 5 for smooth).

(d) Main oil valves must be turned ON.

(e) Clutch must be engaged.

(f) Operation should be monitored at all times and if there are difficulties, the clutch should be disengaged.

NOTE: This equipment operates from the main hydraulic system, therefore the main oil valve must be OFF before operating the undercarriage.

CHAPTER 2

STARTING, RUNNING-UP, AND TAKING OFF: WATER

2.01 GENERAL

(1) When a Canso is on the water, in the eyes of the law it becomes a marine vessel, and as such is subject to all marine regulations. Regulations involving right of way should be particularly noted.

2.02 STARTING AND RUNNING UP ON WATER

(1) The starting procedure for water is similar to that for land. The main feature is that once the engines are started, the aircraft begins to move. This makes it necessary for the pilot to maintain a sharp look out during warm up.

(2) When the pilot calls for a quick start, the flight engineer, after starting the Auxiliary Power Unit (APU), energizes the engines alternately until each energizer is turning over at top speed. He then engages the engines in quick succession, which allows the aircraft to taxi without swinging.

(3) After the aircraft is clear of all obstructions, the engines are run up in normal fashion, one at a time, while the aircraft turns in harmless circles. The engines can also be run up together providing that the co-pilot holds the control column back and a sharp look out is kept for obstacles ahead.

(4) The running up procedure is the same for land or water and is as follows:

(a) Pre run-up check (live magnetos).

(b) Throttle must be advanced to 1800 rpm (20"MP).

(c) Pitch must be pulled through (twice).

(d) Generators must be checked while pitch is being pulled through.

(e) Preliminary magneto check (dead magneto).

(f) Carburettor heat must be checked by the flight engineer.

(g) Throttle should be advanced smoothly to 48" MP (2700 rpm). Flight engineer checks temperatures and pressures.

(h) Throttles should be brought back to 30" MP (or atmospheric pressure) and magnetos must be checked (pilot calls each one out to flight engineer); 2300 rpm.

(j) Idling check.

2.03 TAXIING

(1) The Canso, unlike float planes, has no water rudders and is manoeuvred on the water by a combination of differential throttle, rudder, ailerons, lowering the undercarriage and the use of drogues or sea anchors. Much practice is necessary before a pilot becomes proficient in this art. The art of taxiing on water is in being able to maintain full directional control at low speeds. Since the engines are close to the centre of thrust, it is necessary to rely on other means of keeping the aircraft straight when approaching a dock or beach. Keeping the aircraft straight at high speed presents no problems on water.

(2) Taxiing into wind is an easy matter since the aircraft has a natural tendency to weathercock into the wind. In this manoeuvre, the stronger the wind the better. In winds of 12 k to 15 k or more the aircraft can often be brought to a dead stop with the engines idling, which gives a definite advantage to the pilot. Once the engines are stopped, the aircraft is at the mercy of the wind and tide and often reacts far differently from what is expected. Rudder and elevator are most effective when the aircraft is being taxied into wind. The ailerons are useful, not in causing drag, but in putting one wing down allowing the float to go more deeply into the water increasing the resistance and assisting in turning the aircraft.

(3) Taxiing across wind is more difficult in that the aircraft tends to turn into the wind. It is then necessary to apply more throttle to the upwind engine in order to counteract this weathercocking, causing the aircraft to move faster than is desired. In light winds it is often possible to taxi at low speeds without resorting to the use of drogues and other devices. In very strong winds it is often impossible to taxi the aircraft across wind and the pilot must resort to a system of "tacking" in which he shuts down his engines and drifts downwind as far as possible, restarts and tacks at an angle to the wind.

(4) Lowering the undercarriage is helpful in any form of taxiing, since it reduces the speed of the aircraft, increases lateral stability, and shortens the radius of turn, not to mention the protection it offers against reefs and shallow water. Some Cansos are now modified to allow individual selection of the wheels. The streaming of drogues is another method of maintaining lateral stability in a cross wind, besides helping to slow the aircraft. With one or two drogues streamed on the

leeward side of the aircraft, it is possible to maintain full control at low speeds and avoid both fouling up the leeward engine from idling too long, or overheating the windward engine from taxiing at too high a boost. In taxiing long distances the aircraft engines should be run at approximately 1,000 rpm; at this rate they can be run indefinitely without either fouling or overheating.

(5) Drogues are usually used in pairs when taxiing into wind or downwind, and individually when taxiing crosswind. They will be discussed more fully in the section on beaching, mooring, and docking. Drogues are among the most useful items of equipment on a flying boat, and the pilot should use them as much as possible, otherwise he may find that he is not sufficiently experienced in their use when an emergency arises.

(6) In taxiing downwind, the pilot discovers that his difficulty increases in direct proportion to the strength of the wind. Taxiing downwind in a light breeze is usually not too difficult, particularly if the pilot is going straight downwind with his tail in the eye of the wind. He usually finds that it is rather difficult to get the aircraft going straight initially, but once downwind he finds that bursts of power judiciously applied keep him straight. If he allows his tail to wander out of wind he must apply several times as much power to straighten out again. If the pilot experiences any difficulty in keeping straight, he should lower his undercarriage to avoid heating his engines. If he still has difficulty he can stream both drogues. With drogues streamed and undercarriage down, the Canso may be taxied downwind with little difficulty in fairly strong winds.

(7) If, at this point, the pilot is still unable to maintain control, he should realize that he is involved in very strong winds, and it would be advisable for him to turn the aircraft into wind with his engines idling and control column back, and "sail" the aircraft. He can then move backwards or forwards, or tack sideways at will.

(8) In summary, then, under reasonable conditions the aircraft can be taxied in any direction without use of wheels or drogues if it is not necessary to go slowly. Immediately when seen that undue strain on the engines is likely, the undercarriage should be lowered to provide drag and lateral stability. Drogues may be used in place of undercarriage in certain circumstances, or both may be used at the same time. The control column should always be held back when taxiing in rough water or when using considerable throttle. In strange waters, THE AIRCRAFT SHOULD BE TAXIED WITH THE UNDERCARRIAGE DOWN as a safety precaution to prevent rippling the hull on an uncharted shoal. IT SHOULD NEVER BE ASSUMED THAT THE UNDERCARRIAGE IS UP AND LOCKED AFTER TAXIING. A COMPLETE CHECK MUST BE CARRIED OUT PRIOR TO ANY TAKE-OFF. This may be vital.

2.04 TAKING OFF (NORMAL OR LIGHT WIND CONDITIONS)

(1) A complete take-off check must be done immediately prior to take-off. Since the aircraft is moving and since the pilot must keep alert for floating objects and other hazards, it is easy to miss an important check if extra care is not taken. The pre take-off check list, should be adhered to. After completing the run-up, the best procedure is to bring one throttle back, open the other and allow the aircraft to circle while the check is taking place. By this method the possibility of striking a shoal or floating object is minimized since the aircraft is turning in its own track.

(2) The aircraft should be taxied into the wind for a few seconds until it is past its own swells. The control column is held fully back BEFORE advancing the throttles fairly rapidly to 48" MP.

(3) At this stage of take-off the windshield wipers should be operating as it is impossible to see until the aircraft begins to climb up on the step. If the windshield wipers are inoperative it is necessary to keep the aircraft straight by use of the directional gyro until the aircraft is far enough up on the step for most of the water to have blown off the windshield.

(4) The aircraft very rapidly begins to "rear up" and when it is apparent that it is on the step, the control column should be eased forward until the aircraft is hydroplaning smoothly along the water in a slightly nose-up position. By adjusting the position of the nose slightly, the best angle for acceleration may be felt. If the nose is too high, the acceleration will be slow and the aircraft will tend to stall off the water below flying speed. If the nose is too low, the aircraft will tend to "porpoise" causing a reduction in speed and a strain on the nose wheel doors. If porpoising develops, there is only one way to stop it - pump-handling only makes it worse - and that is to ease gently back on the control column until the action stops. Then the control column may be adjusted forward slightly for best acceleration.

(5) Providing the wings are kept level, it is an easy matter to keep the aircraft straight during take-off by use of the rudders alone. A point directly ahead on the far shoreline, or a gyro heading should be noted immediately prior to take-off, and held. Immediately full power is reached, the full force of the propeller wash is directed to the rudder, allowing strong positive rudder action.

(6) It is important to keep the wings level during a take-off since a dragging float can cause a strong turning moment. To those pilots converting to Cansos and not familiar enough with the aircraft to feel when the wings are level, the following procedure is recommended.

> The position of the port float should be checked during take-off. It should be just above the water when the aircraft is on the step. If it seems unreasonably high above the water, it is possible that the starboard float is dragging. If the port float is dragging, it will naturally be quite apparent. If at any time during a take-off, the aircraft seems to be yawing off course, it is almost certain that the wings are not quite level and that one of the floats is dragging.

If this is watched carefully, keeping straight during take-off should present no problems.

(7) Once the aircraft is hydroplaning on the step the speed builds up rapidly. A lightly loaded Canso comes off the water at 55 k to 60 k. With heavy loads or at high altitudes often it does not come off until 75 k to 80 k is attained. Normally, when the air speed is above 55 k it is safe to assume that the aircraft can be pulled off the water. If a sudden obstruction, such as a log, appears dead ahead when this speed is attained, a sharp pull on the control column causes the aircraft to become airborne. The aircraft may not stay airborne but at least the obstruction is avoided.

(8) Normally, easing back gently on the control column causes the aircraft to become airborne at 55 k to 60 k. This attitude should be maintained until the aircraft has climbed well clear of the water and gained a speed of at least 80 k. Depressing the nose immediately after take-off at such low speeds could have disastrous results.

(9) The floats are then raised and the aircraft climbs away at 85 k to 90 k. The floats should not be raised while the aircraft is still on the step for two reasons:

- (a) If the float strikes the water in a partially retracted position it may damage the support arms; and
- (b) if one engine fails during take-off, the aircraft must be landed straight ahead immediately.

In an emergency, raising the floats immediately the aircraft is on the step is permissible since, with the reduction in drag, greater acceleration can be attained. Also, taking off in an area of floating ice might make it advisable to raise the floats early in order to offer a smaller target to ice floes. It should be pointed out emphatically that once the floats are retracted the pilot is committed to getting off the water, and only an emergency would justify a change in procedure.

2.05 TAKING OFF (GLASSY WATER)

(1) A take-off on glassy water involves exactly the same procedure as above. The following points should be noted, however:

(a) The aircraft has a tendency to "stick" to the water and often considerable force must be applied to the control column to pull the aircraft up.

(b) The airspeed should be watched carefully since a longer take-off run becomes necessary if the pilot attempts to pull off prematurely.

(2) Once the aircraft leaves the water there is no way for the pilot to tell how high he is. Therefore he should carefully maintain this attitude until a definite indication on the altimeter shows that he is well clear of the water: attempting to level out is a very dangerous procedure. Glassy water is a much more solid substance than it looks and is far more dangerous to strike at the wrong angle than rough water. Rough water consists of a series of waves with air spaces in between. Glassy water is solid and can rip the nose out of an aircraft in a twinkling if the pilot is unfortunate enough to strike it in a nose-down attitude.

(3) It is often difficult to get a heavily loaded flying boat or seaplane up on the step during take-off: it ploughs through the water for some distance. One method of getting the aircraft on the step is to rock it. This involves coarse manipulation of the control column fully forward and fully back until the aircraft begins to porpoise. To stop the porpoising action the control column is held back and the aircraft appears to get on the step more quickly than in the normal method of taking off.

(4) It may well be that this procedure assists the take-off of certain types of float plane, but experiments during previous Flying Boat School courses have indicated that the advantage in "rocking" a normally loaded Canso onto the step is mainly psychological. In timing many take-offs with the same aircraft using both methods it was found that it took exactly the same length of time for the aircraft to become

airborne. Experiments were not carried out with overloaded aircraft, so there may be some merit in the method: at least it can cause no damage.

(5) Once the aircraft is on the step the attitude is very important. If the nose is too low water drag increases, if the nose is held too high induced drag increases. In both cases acceleration is slow and take-off run is increased.

2.06 TAKING OFF (CHOPPY WATER)

(1) For the purpose of this section "choppy water" may be defined as water with small whitecaps in winds of 12 k to 15 k. Swells and rough water are discussed later.

(2) Again the procedure for taking off is similar to that under ideal conditions. There is usually more spray during the first part of the take-off but the aircraft attains the step much more rapidly. Once the aircraft is on the step, care should be taken to eliminate all porpoising early to avoid premature bouncing. The attitude is carefully adjusted for the best acceleration. The aircraft should not be allowed to be thrown into the air by wave action, but deliberately taken off when the proper airspeed is reached (55 k to 60 k).

2.07 TAKING OFF (ROUGH WATER)

(1) For the purpose of this section, "rough water" may be defined as that condition in which the surface of the water is disturbed by waves 3 feet high or more and fairly close together. This condition may be found by itself, or accompanying a swell system. The wind is usually strong, sometimes gale force, which is to the advantage of the pilot.

(2) Waves should not be confused with swells. Waves are usually caused by a local high wind condition, in fairly sheltered waters, and although they offer problems to a flying boat pilot, are not nearly so dangerous as swells, which are caused by disturbances a long distance away and are spaced further apart than waves. Swells are often independent of the local wind condition and can occur on glassy water, much to the consternation of an uninitiated pilot. Combinations of waves and swells, very confusing to the pilot, are discussed in a later chapter.

(3) The technique of taking off on rough water is similar to that employed in normal take-off except for the following:

(a) It is not necessary to hold the control column fully back to get the aircraft on the step. Immediately the throttles are opened the nose rises owing to the action of the waves. It sometimes takes considerable strength to force the nose down to the proper position on the step.

(b) As each wave passes there is a tendency for the nose to drop. Therefore the position of the control column has to be adjusted quite rapidly in order to avoid either "digging" the nose, or allowing the nose to rise too high, which results in the aircraft starting to bounce before it reaches flying speed.

(c) If the aircraft does leave the water before flying speed is reached, the pilot has only two choices:

(i) abort the take-off and "stall" the aircraft in; or
(ii) attempt to gain speed between bounces and finally take off.

If he chooses (ii) the pilot must check back very slightly just as the aircraft starts descending so as to lessen the impact with the water and keep the nose up. Under no circumstances should the pilot try to force the aircraft back on the water after bouncing first occurs. This leads to violent digging of the nose, waterlooping and possible destruction of the aircraft.

(4) The pilot should attempt to get the aircraft into the proper flying attitude, on the step, and keep it on the water until a speed of at least 55 k to 60 k is attained. Once this speed is reached the aircraft should come off quite easily. If it bounces at this point the control column should be brought back to avoid further contact with the water. Under normal loading the Canso is not likely to strike the water again, and should become airborne after one bounce.

(5) The tops of waves close together offer a fairly level surface and, if the aircraft is manipulated properly, should not hinder a successful take-off. Also, the wind is invariably strong, which means that a very short time elapses before attaining flying speed: in a 30 k wind, a ground speed of only 25 k is required for take-off.

2.08 TAKING OFF (SWELL CONDITIONS)

(1) Swells generally occur in the open sea or in very large bodies of water. Long, low swells, which are often hidden by a "chop" are sometimes present in large bodies of water. A light swell is usually not noticed until the aircraft is on the water, and often surprises pilots by causing a bounce on relatively calm water.

(2) When taking off into a light swell, the same technique as in rough water should be observed, that is, to maintain the proper take-off attitude at all times until flying speed is reached. By dexterous handling of the control column this slightly nose-up attitude can be maintained as the aircraft accelerates despite the fact that it appears to be going up and down over a series of gentle hills.

(3) Larger swells should be treated with great caution, and under no circumstances should a take-off be attempted into a heavy swell system. If absolutely necessary, the take-off should be made parallel to the swells, even if cross wind. This is discussed in greater detail in the section on open sea landings and take-offs. In general it should be remembered that a seaplane or flying boat can be landed in conditions in which it is sometimes impossible to take-off.

CHAPTER 3

LANDING: NORMAL AND GLASSY WATER

3.01 GENERAL CAUTIONARY NOTES

(1) The prime objective in landing a flying boat or sea plane is to make the transition from air to water as smooth and gentle as possible. There is a particular angle of attack at which a Canso reacts best on a water surface. This angle occurs at approximately 75 k and is such that the only part of the aircraft that touches the water is the rear part of the step, several feet BEHIND the centre of gravity.

(2) At speeds greater than 80 k the angle of attack is too flat or even negative and can cause strong deceleration forces to occur ahead of the centre of gravity. Coming in contact with the water in this attitude is dangerous since the nose-wheel door may cave in, owing to the force of the water, and the aircraft may "water-loop" with disastrous effects.

(3) For example, to gain an impression of the force involved, a person who dipped an oar over the bow of a speed boat travelling at 75 k (87 mph) would find the experience regrettable. If the same experiment were conducted over the stern there would be no violent reaction and the oar would skim over the surface.

(4) Therefore as long as the deceleration forces are behind the centre of gravity, drift which occurs during the landing, automatically corrects itself as the aircraft comes in contact with the water. If the forward part of the aircraft is first to come in contact with the water, violent reactions may be expected. Turning forces may be introduced which are self accelerating and become immediately uncontrollable. A waterloop may well result. This is the highly dangerous effect of poor water technique, and lack of understanding of the very simple principles outlined above.

(5) On the other hand, if the speed is allowed to drop too low before bringing the aircraft in contact with the water, an extreme nose-up attitude results which, while not particularly dangerous, invariably causes the aircraft to bounce in any but the smoothest conditions. Wave or swell action is most conducive to this: it causes the aircraft to leave the water before losing flying speed. "Stalls", "semi-stalls", and "bounces" are discussed in great detail in Chapter 4.

(6) A notion prevalent among the uninitiated that water is soft to land on, is quickly reversed after the first experience of landing in even a light seaplane. The noise and sometimes the force of the impact is startling and it immediately becomes apparent that water at speed, far from being soft, is a potentially dangerous solid. This is particularly true of smooth water owing to its incompressibility; the air spaces between waves in choppy water render it less dangerous although more jarring to land on.

(7) Before any landing is attempted, the landing area must be inspected from the air. A preliminary run at 1,000 feet around the area shows up major obstacles and underwater obstructions. A square circuit should be attempted so that the water may be observed from all angles. The strength and direction of the wind may also be estimated during the circuit.

(8) Not only the landing run, but the take-off run and any taxiing areas should be particularly noted. If a long stay on the water is planned, an alternate take-off area roughly at right angles to the wind should also be noted. Once the aircraft is on the water the field of visibility is very restricted and the pilot is unable to see underwater obstructions until he is upon them.

(9) A dummy run at 500 feet is sometimes helpful in estimating the wind and water conditions and checking for logs, deadheads, and debris. On calm water a dummy run is sometimes unnecessary since logs and obstructions are easily seen. In choppy conditions it is wise to inspect the landing run several times for small obstructions which might be hidden by wave action.

(10) In a light wind the water is what most flying boat pilots would call ideal. There is enough ripple on the water to make it plainly visible but not enough wave action to disturb the attitude of a landing aircraft. Both power assisted approaches and glide approaches may be done in this type of water condition.

3.02 POWER ASSISTED APPROACH

(1) The following procedure is recommended:

(a) Pre-landing check (see check lists in Appendix "A").

(b) Approach at 90 k at approximately 12" MP.

(c) Turn into wind at or above 500 feet.

(d) Long smooth round-out initiated at approximately 20 feet above the water.

(e) By the time the round-out is completed, the aircraft should be a foot or so above the water at approximately 80 k or slightly less.

(f) Hold off and "feel" for the water. In a perfect landing the airspeed at touchdown is approximately 75 k. However, under these conditions it does not really matter if the speed has dwindled, provided that the aircraft comes in contact with the water gently and smoothly.

(g) A slightly nose-up attitude should be maintained, and the control column gradually pulled back as the speed decreases. Once the airspeed is below 50 k the aircraft cannot leave the water and the control column should be slowly eased back. As the aircraft starts to come down off the step, the control column must be fully back. Smooth water is more dangerous than rough water if the nose digs in. Also, the speed by this time is so low that the rudder and elevators have little effect. WATERLOOPING OCCURS MORE OFTEN NEAR THE TERMINATION OF A LANDING RUN THAN AT THE BEGINNING.

(h) The control column should be kept back until the aircraft comes to a complete stop. This tends to eliminate spray from the windshield but there is a more important reason: to prevent a waterloop. As the aircraft touches down at a relatively high speed, 20 k or 30 k sometimes feels very slow to a pilot, particularly after a rough landing in which he has bounced badly. The tendency is to relax once the aircraft has bounced for the last time and finally settled in the water at what appears to be a very slow speed. The pilot might allow the control column to go forward, thinking that his landing is finished. But because the water is rough, or more likely, because his landing was rough, he fails to notice that he is still up on the step, or just barely off and the aircraft still has considerable forward speed. THIS IS ONE OF THE MOST LIKELY TIMES FOR A WATERLOOP TO OCCUR. Therefore, to be safe, the control column should be kept fully back until the aircraft is stopped.

(2) Once the aircraft is down on the water, the flight engineer should carry out a check of the bilges to ensure that there are no leaks.

3.03 GLIDE APPROACH

(1) A glide approach is used in order to land on a lake or inlet where the approach is over hills or high trees. It is not recommended on rough water and is usually fatal on glassy water. A glide approach is seldom necessary, since a body of water which calls for a glide approach would probably be too small for a take-off. But, when a landing is made over a shoreline where it is desired to beach or dock the aircraft, it is often expedient to cut down the amount of taxiing time by landing as short as possible.

(2) A Canso, never very responsive, tends to mush at low speeds.' Therefore the rule in glide approaches is to approach at a higher speed than normal and to allow for a long, gentle round-out. Diving at the water and rounding out at the last second is considered highly dangerous since it is easy to misjudge the height above water. Again, if the speed is below 80 k and the aircraft hits the water too hard, it merely bounces, owing to the attitude; but if the speed is above 80 k it is possible to dig in and waterloop.

(3) Therefore the procedure for a glide approach is as follows:

(a) The approach should be 95 k or more. 100 k is desirable if heavily loaded. (The more speed, the flatter the final approach and the longer the period of float. This makes it easier to judge height before the actual touchdown).

(b) A gentle round-out is begun 20 to 30 feet above the water. The closer the aircraft gets to the water the flatter the angle of approach should be. No violent handling is necessary. The aircraft should be a foot or two above the water on completion of the round-out and flying at approximately 80 k. Under no circumstances should the aircraft be allowed,to touch the water at a higher speed than 80 k.

(c) Procedure continues as for a normal power assisted landing.

NOTE:

If the pilot cannot determine his height above the water at any time, he should go around again and proceed with the glassy water technique.

(4) On contact with smooth water the nose always tends to dig in. Therefore a slight back pressure on the control column is necessary on contact with the water. On choppy or rough water, owing to the wave action, the nose tends to rise, and a very slight forward pressure is necessary on initial contact. On smooth water the control column should never be moved forward and on rough water only with great care, making sure that the nose of the aircraft never goes below the proper attitude.

3.04 MODIFIED GLIDE APPROACH

(1) In the modified glide approach the advantage of the steep glide approach is combined with the ease and accuracy of a power assisted approach, particularly with a loaded aircraft. The procedure is as follows:

(a) Approach at 90 k with throttles closed.

(b) Round-out should be begun at 15 to 20 feet and a little power applied. An experienced pilot should be able to "feel" the correct amount of power but 12" MP is about right.

(c) Procedure continues as for normal power assisted approach.

(2) There is often unlimited space on water and the pilot can afford to use more than the average runway length in accomplishing a smooth landing. These expanses of water offer an opportunity to a pilot to develop his depth perception to a degree where he is able finally to perform a smooth landing in a minimum of space. It is better for a pilot to take his time and use up an extra half-mile of water in order to meet the water smoothly and gently, than to be impatient and ruin an otherwise good landing.

(3) A landing flying boat or seaplane should be going exactly parallel to the surface of the water at the moment of touchdown. Any sudden dropping is liable to cause a "bobbing" motion, which in certain conditions in sure to cause a bounce.

3.05 GLASSY WATER APPROACH AND LANDING

(1) It may be safely stated that "glassy" water is the most dangerous type of water with which a seaplane pilot can come in contact if he uses the wrong technique. At least rough seas are plainly visible, giving the pilot a chance to estimate his height. Glassy water, on the other hand, is dangerous in that it is impossible to see. Unfortunately, there

are pilots who believe that if they get close enough to it they will eventually see it. Many cases are on record of pilots hitting the water without making any attempt to round out with fatal results.

(2) There has been much written on the subject of glassy water landings, and long before the days of instrument flying, bush pilots evolved techniques of landing on glassy water without mishap. These techniques usually involved landing close to a shoreline or to some object so that the height of the aircraft above the surface of the water might be estimated.

(3) Another simple method used often in seaplanes was to reduce power and speed until the nose was above the horizon, and make a controlled descent by use of the throttle until the aircraft came in contact with the water in a tail-down attitude. These landings were good or bad, depending on the proficiency of the pilot, but were always safe, as the aircraft contacted the water in a definite nose-up attitude.

(4) The method recommended in the RCAF is a development of the latter. It involves use of the artificial horizon, airspeed indicator, vertical speed indicator, and manifold pressure gauge. In other words, it is an instrument approach, requiring no visual reference to the water and could be performed safely in a dense fog or on a black night provided that the water were clear of obstructions. A lookout ahead by the second pilot for logs, deadheads, and other obstructions is a necessary safety precaution.

(5) After practice a pilot finds that although he is performing an instrument approach, he is conscious of the aircraft attitude by his side vision and can check for obstacles ahead without taking his eyes off his instruments. This does not mean that a pilot can fly partly on instruments and partly visually on this type of approach. Reference to the horizon or distant shoreline (which is equivalent to the horizon) is an excellent method of determining the all important attitude of the aircraft, and ensuring that the instrument settings are giving him that attitude. This attitude, being the most important factor, should be accurately maintained until contact with the water.

(6) Until a pilot is proficient in this type of approach and can be sure of a perfect one each time, the glassy water approach should be initiated at or above 500 feet. During the first few attempts the pilot may find that he has lost two or three hundred feet getting settled down. It is plain to see that if such an approach were initiated at two hundred feet, the aircraft might well hit the water before attaining the proper attitude.

(7) Glassy water does not necessarily imply mirrorlike conditions. Brown river water is often difficult to judge during overcast or hazy conditions. Rippled water is often impossible to judge during a rainstorm. The only safe rule to apply is: WHEN IN DOUBT A GLASSY WATER APPROACH IS TO BE USED.

(8) The following is the recommended procedure:

(a) Pre-landing check.

(b) Glide at 90 k to the height at which the approach is to be initiated. (500 feet for students). Fine pitch.

(c) Control column eased back to maintain height. (Trim).

(d) As the ASI moves back through 80 k 18" MP is applied.

(e) If the boost is applied at precisely the instant that the airspeed needle reaches 80 k, the needle will continue to 75 k and stop.

(f) The aircraft should be trimmed to maintain exactly 75 k, or at least between 75 k and 80 k. Under no circumstances should the airspeed be allowed to go above 80 k.

(g) After a few seconds for the aircraft to settle down the rate of descent is observed. In a moderately loaded Canso (25000 to 28000 lbs) the rate of descent should be 150 to 200 fpm. The throttle may be adjusted slightly at this point to increase or decrease the rate of descent.

(h) Excessive throttle handling may ruin the approach. Consideration should be given to the lag in the vertical speed indicator.

(j) The aircraft should now be settled and perfectly trimmed for 75 k and 150 to 200 fpm descent. The attitude of the nose is quite high.

(k) The pilot should not look at the water.

(9) Serious accidents have been caused by pilots who, at the last moment, decided that they were almost on the water, pulled off their power and rounded out. This can cause the aircraft to stall in from a great height. The altimeter can be several hundred feet out with regard to sea level, and any amount on lakes. Map spot heights are not reliable for lakes. Some of these have been found to contain up to two hundred feet error on the latest aerial maps.

(10) Sometimes when a little too much power has been applied, it is found that a few inches from the water the Canso refuses to touch down, having built up a cushion of air next to the water. This can be overcome by gently reducing power until the aircraft settles on to the water.

3.06 GENERAL RULES FOR GLASSY WATER LANDINGS

(1) The list of points given below is intended to help pilots in negotiating glassy water landings:

(a) No reliance should be placed on depth perception.

(b) Looking down only confuses and should be avoided.

(c) Flight should be strictly on instruments, using the horizon or distant shoreline as a cross check to ensure the proper attitude.

(d) The attitude should not be changed to increase airspeed, particularly when near the water. At low speeds, lowering of the nose causes the aircraft to drop suddenly, spoiling the gradual letdown and possibly damaging the aircraft.

3.07 TOUCHDOWN

(1) What is done on and after touchdown is as important as the approach itself. On calm water, the nose of the aircraft tends to "dig" and if not checked this action damages the nose doors. Knowing this, an experienced pilot gently checks back just as the aircraft touches, simultaneously closing the throttle. This counteracts the natural "digging" tendency and produces a smooth landing.

(2) The attitude of the aircraft is not as important as when landing in choppy or rough water provided that it is sufficiently nose-up (75 k airspeed guarantees this) and that the aircraft touches the water smoothly without dropping onto the surface.

(3) A rate of descent as high as 500 fpm produces a rough landing and possibly a bounce, but does not cause serious damage to the aircraft if the airspeed is low and the nose is high.

(4) If the aircraft bounces on a glassy water landing, the corrective action is as follows:

(a) The aircraft is held off until fully stalled and allowed to sink in a fully stalled condition with the control column fully back.

OR

(b) Full power is applied for another circuit. The nose should not be lowered below approach attitude until the aircraft is at least 100 feet above the surface.

3.08 LANDING ON CHOPPY WATER

(1) The normal approach for landing on choppy water is as described in a power assisted approach under light wind conditions. Sometimes a glide or modified glide approach may be necessary, but the round-out and touchdown should always be as follows:

(a) The descent is gradually rounded out until the aircraft is in a slightly nose-up attitude a few inches above the water. (75 k to 80 k for a perfect touchdown). A little extra throttle gives a more gradual round-out and better control.

(b) In choppy or rough water the nose tends to jump upwards, necessitating a slight forward check.

NOTE: Checking forward too much can be dangerous. It must be remembered that your action here is not to decrease your landing attitude, but to prevent the wave action from increasing it.

(c) As the aircraft touches down there is a steady rattle or ticking on the hull. The throttles should be closed immediately and the attitude (slightly nose-up) maintained as the aircraft runs along the top of the water. The bigger the waves, the more the nose tends to jump up and the more necessary it is to check forward slightly as the aircraft hits each wave.

(d) As the aircraft slows down the control column is approximately neutral as the all-important attitude is maintained. On the final half of the landing run, the control column should gradually be brought back. Once the speed is below fifty knots it is impossible to leave the water, but the most likely time to have a waterloop is approaching.

(e) On initial touchdown, a pilot has good elevator control: normally enough to correct any inadvertent "digging" of the nose. However, at the lower speeds elevator control begins to drop off, particularly around 30 k when the aircraft begins to come off the step, and if the nose of the aircraft digs in at this point, it becomes too late to pull back on the control column.

(2) In any type of landing on water, the control column should be right back from the time the aircraft begins to leave the step until it comes to a dead stop.

(3) The most important factor in landing on choppy water is the ATTITUDE of the aircraft. If the nose is too low it can be very dangerous. If the nose is too high, the aircraft bounces.

(4) If the aircraft is stalled after a bounce the control column must be right back and firmly gripped otherwise it is wrenched from the hand as the aircraft hits the water. There is no excuse for bouncing more than once. A fully stalled aircraft will not leave the water, although it may appear to be bouncing. This is called "bobbing" since the tail is usually in or very nearly in the water.

CHAPTER 4

LANDING: ROUGH WATER

4.01 GENERAL

(1) As already defined, rough water, as it applies to Canso handling, has waves three feet high or more, closely spaced, in a moderate to strong wind. If this condition is accompanied by swells, it constitutes an entirely different situation, which is described in some detail under the heading of "Open Sea Landings".

(2) There are two methods of landing on rough water: by means of a normal power assisted approach, and by what is generally called a semi-stall landing. A third method, usually inadvertent, consists of a power assisted approach, a bad bounce, and a stall off the end of the bounce. This has happened to the most experienced of water pilots and is possibly the strongest reason why the stall technique should be fully understood.

4.02 POWER ASSISTED APPROACH

(1) The power assisted approach is similar to that used on choppy water, except that since the nose has a greater tendency to rear up on each successive impact with the waves, it is necessary to hold it down in order to maintain the proper attitude. But this is not as simple as it sounds. If, for example, the control column is held forward steadily after touchdown, far worse results than mere bouncing may ensue. Tremendous forces are involved and the pilot must know exactly what he is doing and what to expect.

(2) The aircraft should touch down as smoothly as possible in the normal attitude (75 k to 80 k). The power is taken off immediately the aircraft touches. A series of jolts shake the aircraft, and the nose immediately starts to jump up. The pilot with a sense of rhythm soon learns to feel the rhythm of jolts from each successive wave and check forward slightly as he hits each wave. Between waves he is checking back slightly so that the attitude of the aircraft remains constant. As the aircraft slows down, the interval between jolts becomes longer, and the pilot controls the aircraft accordingly. The airspeed should be checked carefully, and when it is below 50 k the control column should be moved steadily back. In very rough water, the aircraft sometimes appears to bounce, but with a speed below stalling, it does not stay in the air for long. Occasionally a pilot may bring the control column back too soon, and the aircraft leaves the water in one long bounce. The control column should then be held right back and the aircraft "floats" clear of the water until the remaining flying speed is dissipated, and the aircraft settles into the water with no further bouncing. Very rough water merely causes the aircraft to bob up and down considerably.

(3) Only experience can tell the pilot the exact moment at which to cease checking forward and begin the steady backward pull on the control column. It should be noted that it is far less dangerous to check back too soon than to hold the nose too far down and cause dangerous deceleration forces to operate ahead of the centre of gravity. Serious accidents during water landings can be attributed mainly to lack of knowledge of this principle.

4.03 STALL AND SEMI-STALL TYPE OF LANDING

(1) The only real difference between the stall and semi-stall type of landing lies in the matter of the height at which the stall is performed. Many experienced pilots have argued the merits of one against the other, but the terms have become so interchangeable in the last few years that their exact origin seems to have been lost in obscurity.

(2) For the purposes of this manual, a semi-stall landing is a landing in which the aircraft reaches the stalling speed as it touches the water. A stall landing is one in which the aircraft is fully stalled some distance above the water.

(3) Fortunately, the Canso aircraft maintains a nose-up attitude throughout a stalled condition, provided that the control column is held fully back. This feature is very convenient in performing a stall type landing. The approach for a stall or semi-stall landing can be made at any speed or at any power setting. Unless circumstances dictate otherwise, a glide approach is usually the most expedient.

(4) In a semi-stall landing, the aircraft glides to a point approximately fifteen feet above the surface of the water at which point it is held off until it becomes fully stalled and begins to sink. If performed perfectly the aircraft touches the water exactly at this point. If it touches a moment too soon the aircraft bounces at least once; a moment too late and the aircraft drops rather heavily on the water but does not bounce. The latter is an unconscious example of a full stall landing. The advantage in stalling the aircraft a little higher off the water is that the pilot can be sure to avoid bouncing. Also, the forward speed is slightly lower, although the rate of descent is slightly higher.

(5) The pilot has aileron control during the stall and is able to keep his wings level in the normal way. The rate of descent builds up slowly, so that for the first few hundred feet of descent, the rate of descent is less than 500 fpm. Eventually the aircraft reaches a terminal velocity of approximately 1500 fpm downwards but maintains a nose-up attitude and aileron control; at the same time the forward speed drops off considerably.

(6) A stall type landing is usually performed when the water is too rough for a normal type of landing or when a normal landing has produced a large bounce and there is not room enough to go around again. It ensures that the aircraft will get down on the water without leaving i again. A full stall performed well above the water (approximately 25 to 30 feet) is advisable under extremely rough water conditions or in an emergency. The main advantage of this method is that although the downward rate of descent is greater, the forward speed is much less than in the semi-stall. In large swells, the aircraft would, of course, be landed parallel to the major swell system, regardless of the wind (see "Open Sea Landings").

(7) For fairly rough water or for practice, a semi-stall type of landing is advisable. The following is the procedure for practising semi-stall landings. (Note: Semi-stall landings should not be practised on smooth water. It is very hard on the aircraft. Choppy water with scattered whitecaps presents the ideal condition. The reason for this is that smooth water causes considerable pressure on the hull. See Article 3.01 para (6).

(a) Approach into wind at 90 k (approximately).

(b) Throttle back.

(c) Round-out should be initiated 15 to 20 feet above water.

(d) Height should be held by gently easing back on the control column until it is fully back (before touching the water).

(e) The control column should be tightly gripped making sure that it is all the way back when the aircraft hits the water. (See Article 3.03 para (1) (h)).

(8) Stall type landings should be mastered and fully understood, even if only to build up the confidence of the pilot in the aircraft. Although sometimes a little hard on the aircraft, they are invariably the safest way of getting the aircraft down on rough water in an emergency.

CHAPTER 5

OFF-SHORE TAKE-OFF AND LANDING (SWELL CONDITIONS)

5.01 GENERAL

(1) Successful off-shore take-offs and landings can be and have been made in Canso aircraft, even under adverse weather conditions. However, due to the design and construction of these aircraft, landing and taking off in the open sea is, at best, a hazardous operation and only justifiable under conditions of extreme emergency.

(2) Much of the information in this chapter is derived from experiments carried out by Commander McDiarmid, U.S. Coast Guard, who performed over 240 off-shore landings during tests carried out for the RAF and USAF.

5.02 LANDING SPEED AND SURFACE CONDITIONS

(1) The higher the landing speed the more violent is the behaviour of the aircraft landing in a sea, and damage to the aircraft, which may adversely affect its hydromatic performance, is to be expected. Because of this cumulative effect, every effort should be made to reduce the landing speed.

(2) The experienced pilot of a seaplane about to attempt a landing in a substantial sea, tries to find a lee. Tests have indicated that a ship circling at 12 k with hard over rudder reduces much of the roughness and swell inside her turning circle after about three circles are completed. If there is a ship present, the pilot of the aircraft may be able to get the captain to circle his ship to obtain a much easier landing surface. The pilot can then make his approach, either into wind or with the remaining swell abeam, whichever looks easier, and drop just inside the circle to complete his run before crossing the whole of the circle.

(3) A landing can be made in the lee of a very large vessel if she steams slowly ahead with the sea on her beam. If there is no vessel present or the pilot does not have time to wait for the circle to be made, he must make the best of the sea.

5.03 SWELL SYSTEMS

(1) Commonly, the sea is made up of one or more swell systems roughly from 200 to 1,000 feet from crest to crest, travelling from 20 k to 45 k, and covered by a chop which is driven by the local wind. The swell is not necessarily going with the wind, but is rarely going directly against it otherwise the swell would slowly stop. More often the wind drives the chop across the swell at an angle of from 15 to 80

degrees. Often two swell systems are a few degrees apart, but of greatly different period so that periodically one overtakes the other and forms, momentarily, a swell roughly equal to the sum of the heights of the two swells forming it. Then, a moment later, the two systems are in opposite phases and the crests of one system fill the troughs of the other and the sea makes a relatively easy landing surface.

(2) The chop is always on top of the swell. Many inexperienced observers think that the chop is the whole of the sea disturbance and credit it with great heights when it forms peaks on top of the in-phase swells. (ie, when one swell overtakes another).

(3) The pilot about to land should observe the swell from about 2,000 feet, for at a lower relative altitude it is almost buried under the chop. He should remember the compass heading from which he observed the most formidable swell system. If there are two formidable swell systems running at an angle of from 60 to 80 degrees, he should plan his landing run to go down one and parallel to the other, as much into wind as possible. The wind, unless it is blowing at 20 k or more, is definitely the last consideration. When touching down on the water he should trim his wings, as long as he has control, to the sea surface under him, not necessarily to the horizon. When landing on the peak of an oncoming swell the point to touch down is at the top or just beyond the top of the swell. The rising side of the swell should be avoided in touching down for the plane is then forced into a radical change of direction which subjects it to very severe shock. After touching down, the nose should be kept up as long as possible. Experiments have proven that landing into the face of a swell constitutes a serious hazard.

5.04 GENERATION OF SEAS

(1) Before he is able to judge a sea the pilot must understand the mechanics of its generation, life and dissipation and the effect of one disturbance on another, and finally the effect of the whole considerable distance of the landing run at high speed before coming to rest.

(2) When the wind blows, the drag of the wind on the water builds up waves. These grow higher and higher, and the distance between crests becomes greater as they travel along driven by the wind. The distance over which they are driven while building is called the "fetch". The heights and lengths they attain are proportional to the strength of the wind and the length of the fetch over which it is effective. Generally speaking, the ratio of height to length of seas building up in deep water does not vary much from about 1:13. When the wave has travelled away from the area of its birth and the wind which caused it, it gradually grows longer, lower and faster and the slope

changes from a fairly steep 1:13 gradient with little peaks through a loxodromic curve to finally a sine curve. When it has travelled several thousand miles, it is quite low, but long and moving very fast. Off the coast of southern California the velocity of such swells has been measured at over 48 k and off the Cape of Good Hope at over 80 k.

(3) Fast swells are to be expected in areas a few hundred to several miles away from great storm areas and in the line of movement of the swell systems generated in those areas.

(4) Fast swells may be recognized in the air by their slow period. Both their lengths and velocities can be computed by dropping a smoke float or any object that will float and be clearly visible below. By timing the passage of successive crests past your mark - best done by averaging four or five owing to the difficulty of picking the middle of a sine wave by eye - a pilot can call the period of the wave in seconds. Using an example of 7 seconds, and applying Scripps formula the following can be determined:

(a) Length of the Swell = 5 (Period of the Swell)^2

(b) Velocity of the Advance of the Swell = 3 x Period of the Swell.

e.g. according to (a) 245 (feet) = 5 $(7)^2$ (seconds)

according to (b) 21 (knots) = 3 x 7 (seconds)

(5) A pilot attempting to land in a very fast swell finds that the seas seem to be suddenly steep and fore-shortened when he is right down over them. Actually his relative speed across the crests is the total of his ground speed and the speed of the swell. The seas are no steeper, but he is, in effect, landing 20 k to 30 k faster than his ground speed as far as the bumps are concerned.

(6) It is important that pilots understand that the moving swell is moving just as a wave moves across a carpet when it is shaken at one corner. The whole carpet and its individual pieces remain undisturbed. Only the wave moves. So as a wave or swell moves across the sea surface, the actual translation of sea mass or water particles from one area to another is comparatively negligible. Of course, a high tide coinciding with an onshore gale is higher than normal, but movement of water is tiny compared to the swell itself. This is most apparent to a mariner drifting in a small boat or raft on a slick sea with a great swell. He simply rises and falls. Landing in these conditions is like rolling onto a strip with a deep dip or a short rise in it: the aircraft tends to become airborne after rolling up the inclined part. In the sea

dips and rises are constantly moving down the runway; the dangers of them may best be avoided by landing on a runway along the side of the swell; this whole runway tilts sidewise and slowly rises and falls as on a longitudinally almost level surface. In its action, it gives the aircraft a slight tendency to bounce as it rises and to land above it as it drops away.

(7) The presence of several swell systems moving 30 to 80 degrees apart and possibly of very different heights and periods covered by a formidable chop constitutes a confused sea. The best general rule of procedure here is to land parallel to the more formidable swell system on the heading that takes the aircraft down swell on the secondary system and as much into wind as possible. The order in which the above factors are presented indicates their relative importance, unless the wind is very strong. The pilot may reasonably decide to land into the wind if it is 20 k or above. He should remember that the wind direction is more important with a slow landing plane than it is with a fast one.

(8) In a confused sea, "freak" seas of very considerable heights are to be seen here and there. A pilot should be mentally braced to find one suddenly rising ahead of him very unexpectedly on the landing run. If he sights it in time, it is possible for him to swerve the landing path slightly and miss it.

(9) The fact is that landing parallel to or down the back of a long, fast swell in calm conditions is a relatively simple matter. A rough short sea sadly complicates the problem of abandoning the aircraft after ditching. Pilots compelled to ditch should choose an area having little or no surface wind whenever possible.

(10) Many pilots fear crosswind landings on the water and feel that they invite waterlooping. Curiously, the sharp jerk felt when a plane is landed crosswind on smooth water is not noticed in rough water, partly because the landing and run-out are rough anyway and probably partly because there is an eddy of wind on the leeward side of a large swell or wave which drags momentarily into the prevailing wind.

(11) The illustrations (Figs 1 to 3) show simply how the profile of a wave is made up. When landing across a swell system (as in Fig 4) the little waves (the chop) are crossed very fast and they are felt as hard vibrations and hard bumps, but the long, low, buried swell is the factor that is most likely to throw the aircraft out of control while running fast. It is almost impossible to show in a drawing how wave and swell systems crossing at broad angles affect one another; however, some attempt is made to do so in Figure 5.

5.05 DITCHING STATIONS

(1) On making an offshore landing at sea, crew members and passengers should be warned to take up correct ditching stations prior to landing, and if harnesses are available they should be securely strapped in in the islands of safety in the aircraft. Under no circumstances should crew members be permitted to remain in the nose or tail sections during landing.

5.06 TAKE-OFF

(1) A seaplane can be successfully landed on a sea which is too rough to permit a safe take-off. Normally this is due to the length of time and take-off run required to attain airspeed and to become airborne; during this run the aircraft takes a very heavy pounding and may be thrown into the air with insufficient airspeed to maintain control.

(2) As in off-shore landings, a sound knowledge of sea and swell conditions is essential and the pilot must use his own judgment about whether to attempt to take off. During take-off, care must be taken to keep the wings level in relation to the seas under the aircraft, and the control column must be held well back to prevent the nose from digging (see Article 2.07).

5.07 JET ASSISTED TAKE-OFF (JATO)

(1) By its extra thrust JATO greatly shortens the critical take-off phase in rough water operations and, even in very rough seas, may assist in the otherwise impossible take-off of a heavily laden aircraft. JATO does not reduce the inherent hazard of open sea operations, but gives the pilot a better chance of completing such operations, when they become necessary. JATO also makes it possible to take off in restricted areas where take-offs under normal power could not be made.

5.08 ESTIMATION OF WIND ON WATER SURFACES

(1) The action of wind on water creates effects which give a definite indication of the wind speed and direction. A light wind forms ripples on the surface (Fig 1) and as it increases in strength the ripples grow larger until, at about 8 k, small waves begin to form. The crests of the wavelets break off and slide back INTO WIND as foam. (Fig 2).

(2) Dispersed white caps appear at approximately 15 k and at 20 k the sea has a distinctly rough appearance. As the windspeed increases, the waves grow higher until eventually at about 35 k the crests of the waves are being blown forwards as "spindrift" (Fig 3). With a steady wind this forms regular parallel lines (windlanes) at right angles to the wave lines (Fig 4).

5.09 WINDSPEED TABLE

(1) The table below details the sea state for various windspeeds.

8 k to 10 k	Appearance of foam.
15 k	Appearance of dispersed white caps.
20 k and above	Sea has distinctly rough appearance.
35 k and above	Foam is blown in regular streaks from the crests of white caps.

Fig. 1
Less Than 8 k

Fig. 2
8 to 10 k

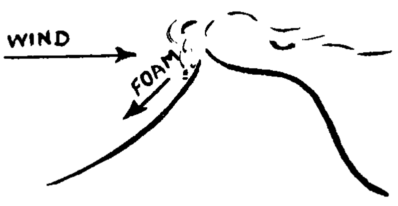


Fig. 3

35 k

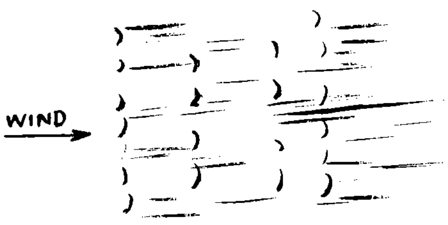
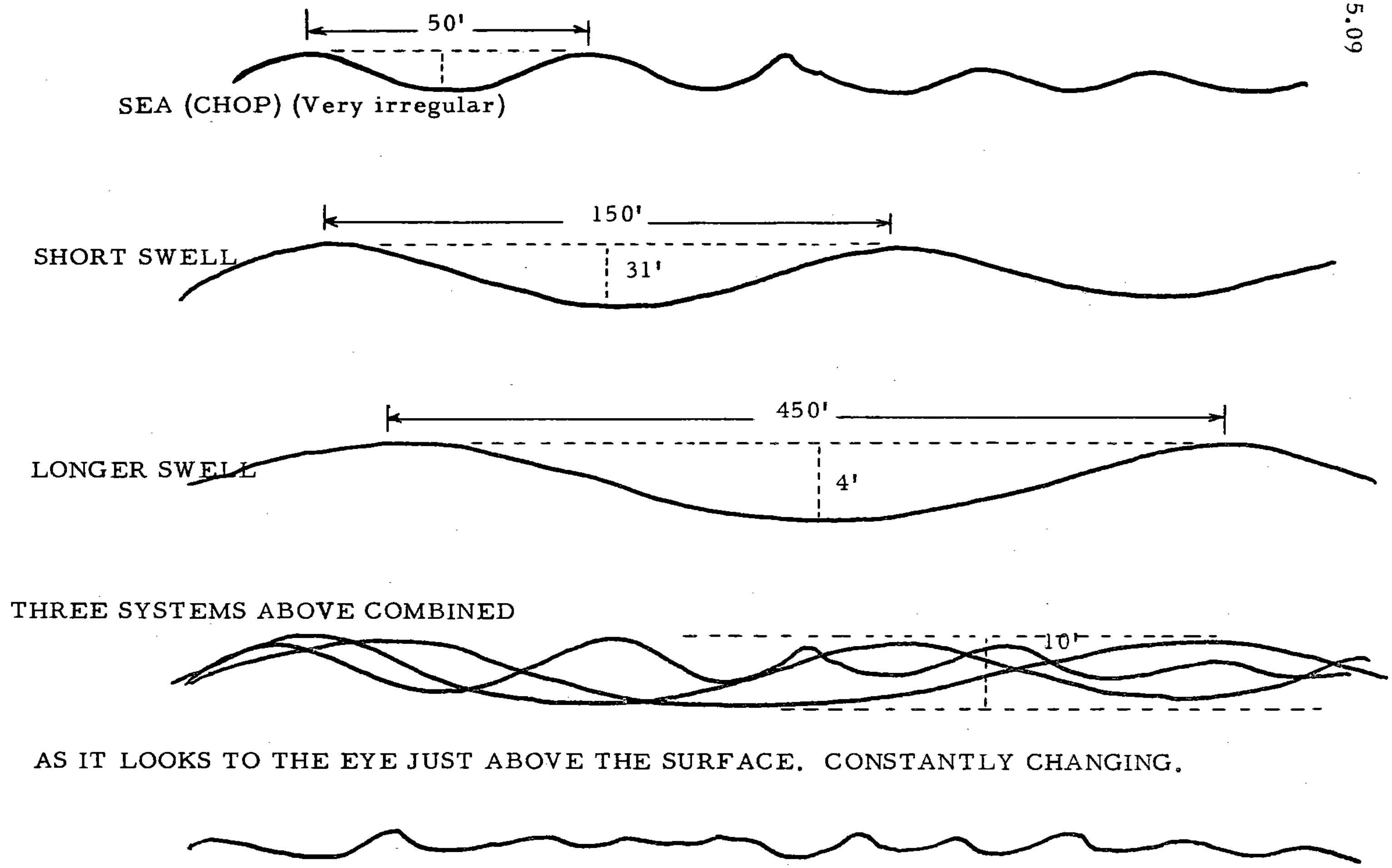


Fig. 4

35 k or more


50'
SEA (CHOP) (Very irregular)
150'
SHORT SWELL
31'
450'
LONGER SWELL
4'
THREE SYSTEMS ABOVE COMBINED
10'
AS IT LOOKS TO THE EYE JUST ABOVE THE SURFACE. CONSTANTLY CHANGING.

CHAPTER 6

BEACHING

6.01 GENERAL

(1) Beaching is the act of manoeuvring a seaplane or flying boat onto a beach and securing it against further movement. The aim of a beaching operation is not to taxi the aircraft toward the shore until it hits the beach; it is not even necessary for the aircraft to ground during a beaching. Aircraft ground themselves more often than not but this is not absolutely necessary.

(2) The perfect beaching operation is one in which the aircraft comes to a complete stop while still floating and with one wing float over the beach. In this instance, a successful securing manoeuvre can be carried out by one man, provided that the wind is light. On the other hand, if the aircraft has been driven on the beach it takes a large number of men to pull it off, not to mention possible damage to the hull from stones, gravel or rocks.

(3) The end object of a beaching operation is to have the aircraft secured against the shoreline with the tail over the shore. The aircraft is usually secured by two wing lines and one tail line attached to trees or other immovable objects.

(4) It is impossible to lay down a series of steps which when followed gives the perfect beaching. Every body of water has its own features. Every beach is different. The change of wind or water current can affect conditions decisively. Therefore, a flying boat pilot must learn to assess each situation as an entirely new situation and learn to expect the unexpected.

(5) Since several men must work together to perform a successful beaching, the captain's ability to organize and handle his crew has a direct relationship with his success in such an undertaking.

6.02 SURVEY OF THE BEACHING AREA

(1) After a preliminary survey of the water body (see Chapter 3) a survey of the beaching area is conducted by flying as low as possible over it without coming too close to such obstructions as high trees and power cables. The following points should be borne in mind during the survey of the area:

(a) Type. Should be free from rocks, shoals and sandbars; preferably it should be sand, gravel, or mud.

(b) Protection from weather. Should be in a cove or on the leeward side of a point or island. Consideration should always be given to the prevailing winds. A bluff of trees on the land side affords protection.

(c) Depth of water at shoreline (slope of beach). If it is tidal water, the range of tide and the proximity of fresh water are considerations. Sometimes it is a good idea to take a compass bearing from the beach to the nearest fresh water lake to aid in finding it after setting up camp.

(d) Tie down area. There should be a means of tying the aircraft down close to the camp site.

(e) Provision for moving the aircraft, in the event of gales or floating ice.

6.03 WATERBORNE PROCEDURE

(1) After every feature of the water body has been checked (landing and take-off areas; the taxi path to beach with its neighbouring obstructions; the beach itself) and the crew briefed on their duties, the aircraft may be landed and beached.

(2) In strange waters the aircraft should be taxied with the wheels down. (See Article 2.03). If it is apparent that a wheels up beaching may be carried out, it is a simple matter to circle and approach the beach when the wheels are FULLY up and locked. A partial retraction can cause serious damage.

(3) Drogues should be used (See Article 2.03 para (4) & (5). Under certain conditions it is wise to hold the drogues until the aircraft is lined up on its final run as it is sometimes difficult to turn sharply with drogues streamed.

(4) Before the aircraft gets close to the beach, wing men must be posted and wing lines tied. Sometimes, for convenience, a tail line is tied and carried up to that wing tip which the pilot intends to put over the beach. This facilitates turning the aircraft around when ashore.

(5) A SLOW APPROACH is imperative: the slower the better. Normally, when approaching a sandy beach, the wheels are up and the only drag is provided by the drogues. The pilot should manoeuvre so that his final approach path is a straight line. It is very difficult to turn the aircraft accurately at slow speeds near the shore, and impossible to turn without speeding up slightly, (through having to use power on one engine).

(6) An approach which is nearly parallel to the shore is also desirable where room allows. Such a course in the final stages of the approach offers more opportunity for going around again than a head-on approach where, once close in, the pilot is committed for better or for worse.

(7) It should be borne in mind that the end object is to have the aircraft tail-in to the shore, so that the nearer the aircraft approaches this position under its own power, the less manhandling is necessary.

6.04 OFFSHORE WIND

(1) Beaching the aircraft in an offshore wind is a reasonably simple operation, provided that the beach is free of obstructions and the approach path is clear. If there is doubt, the wheels should be left down. (The aircraft can always be refloated and the wheels pumped up). The approach should be at an angle, if possible with one wing float over the beach. One wing man should be stationed as far out as possible on the off-shore wing, and another wing man inboard just outside the engine on the onshore wing. As the aircraft comes to a stop (or grounds) with the wing float over the beach, the onshore wing man goes to the wing tip and the offshore wing man comes inboard, thus lowering the float to the beach and holding the aircraft for a time. The rest of the crew, with the exception of the pilot and flight engineer, then disembark via the onshore wing tip, and turn the aircraft around.

(2) In a very strong wind, when it is often impossible to approach the beach at an angle, a straight-on approach is made with a crewman stationed in the nose of the aircraft. As the nose grounds, the crewman wades ashore with a line and attaches it to a tree or other object. While this is being done it is often necessary for the pilot to hold the aircraft on the beach with engines.

6.05 WIND PARALLELING BEACH

(1) Ideal conditions for beaching exist if the wind direction is parallel to the beach. The aircraft taxis into wind dead slow until it stops with one float over the beach. In strong winds the engines should sometimes be kept on until the aircraft is partially secured. Again, it is necessary for the crewmen to move the wing tip floats up or down on signals from the captain.

6.06 ONSHORE WIND

(1) An onshore wind combined with a small beach having obstructions near the waterline, makes beaching a very tricky operation; combined with a long, wide beach, it makes the operation very simple. All that is necessary is to taxi as close to the beach as practicable, initiate a turn into wind, and shut down the engines.

(2) Owing to its natural weathercocking tendencies, the aircraft turns into wind and drifts back on to the shore, tail first. Use of the rudders and ailerons can cause the aircraft to "tack" a few degrees either way. Placing one or more men on one wing tip causes one float to go into the water, setting up considerable drag and helping to turn the aircraft slightly out of wind. This is called "sailing" and is an art requiring a certain amount of practice before proficiency is acquired. With a very strong onshore wind (15 k to 20 k or more), the aircraft sails backwards with the engines idling. This contributes an additional safety factor in that the aircraft is always under control and can be manoeuvred quickly if necessary.

(3) In conditions of very light onshore winds no attempt should be made to sail the aircraft as the operation soon deteriorates into an aimless drifting 30 or 40 feet from shore. A parallel type of approach with drogues should be employed and an attempt made to put a float over the shore.

6.07 OBSTRUCTIONS ON THE SHORE

(1) If there are large boulders on the beach that the float is in danger of striking the beaching process is slightly modified. The crewman on the onshore wing is waved out and the offshore crewman is waved in. The onshore wing float, now in the water, grounds immediately it hits the shore. The crew then jump from or climb from the wing tip and secure the aircraft.

6.08 SECURING

(1) Once an aircraft is beached it must be properly secured with lines. The aircraft is manhandled to a tail-in position and lines are attached to rings in the leading edge of the wing and a ring on the underside of the tail. The rings on the rear of the floats are not used for tie-downs owing to the inherent weakness of the structure during side thrust. However, they are sometimes handy for use by a shore crew, being more easily accessible than the fixtures in the leading edge of the mainplane.

(2) When beaching on a rocky bottom in tidal waters, or where rough water is expected, if the wheels are not already down, the aircraft may be pushed out manually and the undercarriage may be lowered and locked, affording excellent protection against rocks and pounding by swells. With a receding tide, the brakes can be set and the aircraft will be left high and dry. THE AIRCRAFT SHOULD NOT BE LEFT ON ITS HULL IF THE TIDE IS RECEDING. One stone the size of a fist can be forced through the hull if caught between the hull and the beach.

(3) If there are no trees to secure to, there are several substitutes. A Canso anchor, buried at a thirty degree angle with a cable attached is as strong as the cable itself. Some pilots carry a spare anchor on northern operations solely for that purpose. "Deadmen" offer another method of securing lines. A deadman is a log, 4 to 6 feet long, which can be buried at right angles to the pulling force and has exceptionally good anchoring qualities. If no deadmen are available, it is possible to tie lines around large rocks and boulders, but care should be taken to protect the lines against fraying. A gently bobbing aircraft can fray a line through in a very short time.

(4) In summary it should be remembered that no two beaching operations are exactly alike, even on the same beach. The qualified captain, therefore, evaluates each situation before approaching the beach, briefs his crew thoroughly and anticipates difficulties - even unforeseen ones, by allowing himself a way out. On the other hand the impetuous pilot who does not make full preparation is a potential wrecker.

(5) There are several other methods of beaching a Canso in unusual or difficult circumstances, among which the following are typical:

(a) Anchoring and Winching. A Canso may be anchored slightly offshore and a tail line taken ashore by boat. The aircraft is then pulled gradually onto the beach as the anchor cable is paid out. The advantage of this method is that the aircraft is under control at all times and is less likely to be damaged on a rocky or restricted beach.

(b) Reconnaissance by Boat. If the captain is not sure of the beach and if the wind is calm, he may shut down off the beach and dispense with the anchor. A man may then be sent ashore by boat with a line and, after inspecting the beach, haul the aircraft in. If the aircraft is too far out for a line, the captain may restart, after getting the crewman to report on the beach condition, and carry out normal procedure.

(c) Buoying Offshore. In some localities it is possible to moor the aircraft to a buoy near the shore, then work it onto a beach or dock. The aircraft can then be winched back to the buoy after unloading, reducing the chance of damage.

CHAPTER 7

DOCKING

7.01 GENERAL

(1) Unfortunately, there are very few docks available which were designed specifically for flying boat operation. Float planes are usually easier to dock than flying boats because of their manoeuvrability on the water, and the ease with which they can be handled by one or two men. Flying boats offer a problem because of their poor manoeuvrability at slow speed, their wing tip floats which are always in danger of colliding with the dock, and their large size which necessitates the presence of several men for handling, particularly in windy conditions.

(2) A fully loaded Canso weighs approximately 15 tons, which means that collision with an immovable object, even at one or two knots, is bound to cause damage. If the dock is small and flimsy, a slight bump may wreck the dock completely. On the other hand, the nose of a Canso can be crushed very easily by coming into contact with a solid, immovable dock.

(3) The problem, therefore, is similar to that in a beaching operation except that even greater care is necessary to avoid damaging the aircraft. If the aircraft can be brought to a complete stop a few feet from the dock, it can be considered a perfect docking. The object of the operation is NOT to hit the dock.

(4) The proper method of approaching a dock, buoy, or beach is in a long approach AT THE SLOWEST POSSIBLE SPEED, ensuring that the aircraft is under complete control long before the last chance to turn around has disappeared. Patience is a virtue in this instance. Many aircraft have been damaged simply because the pilot was too impatient to make another approach, or even several, until he was sure that he was approaching at the best possible angle, at the lowest speed, and under complete control. The long approach is valuable in that it gives the pilot an opportunity to experiment with his controls at minimum speed and assure himself that what he is attempting to do is, in fact, possible under the particular circumstances. If the aircraft is going to swing violently when the throttles and speed are cut right back, the time to find out is well out from shore, so that another attempt can be made using a slightly different procedure.

7.02 TYPES OF DOCK

(1) The ideal type of dock for use with Canso aircraft is a "T" shaped dock extending out from shore at least 50 feet. It should be a floating type projecting out of the water not more than one foot. A dock projecting up to four feet from the water may be used providing the accessway is close to water level, allowing the wing tip float to clear it. Any higher obstruction is bound to interfere with the propellers.

(2) Any floating dock which is low and fifty feet clear of obstructions may be considered reasonably safe. A small scow moored to a buoy is usually easy to approach since it is always streamed downwind. Docks which are high and solid, particularly those with an abundance of pilings close by should be avoided at all costs. If it is absolutely necessary to approach this type of dock because of an emergency, the only safe method is to anchor or moor to a buoy well off the dock and then manhandle the aircraft into the dock by use of lines.

7.03 APPROACHING THE DOCK

(1) Docks can be approached on a head-on or parallel course, depending on the current, wind, and general situation. Again, as in beaching, it is impossible to lay down a definite sequence of actions for approaching any dock. For this reason again, planning, patience and anticipation of all possible hazards are the only safeguards against mishap.

(2) If the dock is being approached head-on, it is necessary to have a crewman in the nose with a length of line and preferably a crewman on each wing, also with a line, to assist in manoeuvring and to guard against unforeseen hazards. To afford more drag and, consequently, greater stability and control, the undercarriage should be lowered. In a head-on approach it is better to UNDERSHOOT than to overshoot. It is much simpler to restart the engines in order to move ten feet than to repair a crumpled nose or wing float.

(3) In a parallel approach, the same principles apply. Every possibility should be covered. The approach should always be made into wind and into the current whenever possible. (A 5k current has a definitely stronger effect on an aircraft than a 5k wind. When in doubt a dummy approach may be made well off the dock in order to test control of the aircraft at very low speeds).

(4) In a parallel approach the inshore float must be raised out of the water high enough to clear the dock. This is done by placing the heaviest crewman on the offshore wing, or having the offshore crewman stationed further out on the wing. It should be remembered that this causes a slight turning tendency away from the dock when the engines are cut, due to the drag of the offshore float. This can be compensated for by the use of drogues if necessary. The undercarriage may also be used, but great care must be taken to ensure that the main wheels do not suffer any damage from the dock, or vice versa. If the docking is carried out properly, no part of the aircraft touches the dock until the aircraft is fully stopped, then the aircraft is held off the dock and the undercarriage pumped up.

7.04 SUMMARY

(1) It cannot be emphasized too strongly that each docking is entirely different and that it is the pilot's responsibility to analyse each situation and use every available resource to accomplish a safe docking. Taking advantage of the wind and current, using undercarriage and drogues, "blipping", engines, using crewmen to raise and lower the wing tip floats, "sailing" and other tricks can all be used in certain circumstances. But only practice can guarantee the effectiveness of these procedures. The proper place to practise is out in open water where there is no danger of collision - NOT while approaching a dock.

CHAPTER 8

MOORING TO A BUOY

8.01 GENERAL

(1) Mooring is probably the easiest and safest waterborne operation in a Canso. In general it consists of merely taxiing up to a buoy in such a way that the crewman can catch the "D" ring of the buoy with a buoy hook. Although this sounds simple, when the buoy is in an awkward position, or near to the shore, it is possible to have a mishap.

8.02 APPROACHING AND MOORING

(1) A buoy should always be approached into wind as slowly as possible. The undercarriage should be up to avoid tangling the nose wheel doors with the mooring cable. For the last few hundred feet the engines may be blipped to further slow down the aircraft. Both drogues should be streamed prior to the final approach.

(2) On reaching the buoy, the aircraft should be almost at a dead stop, enabling the crewman to reach down and hook the buoy. He then puts a slipline through the "D" ring and secures the aircraft to the buoy from the snubbing post. For a temporary mooring this is generally adequate.

(3) For mooring the aircraft to a buoy for a longer period or for overnight, the following procedure should be carried out:

(a) The mooring bridle is unfastened and its retraining lines are attached to the snubbing post. If this is not done, the bridle may slip into the water before being fastened, and because it is attached on the underside of the hull well below the waterline, may be impossible to retrieve without diving.

(b) The buoy mooring pendant is pulled up with the retaining cable or chain (sometimes called "lazy chain") which is found hanging down from the "D" ring on most buoys.

(c) The mooring bridle is attached to the strop or grommet on the end of the mooring pendant by means of a clevis.

(d) The slipline is loosened until the full weight of the aircraft is taken up on the aircraft bridle (sometimes called the "lizard").

(e) The slipline is left attached in order to pull the aircraft up to the buoy when it is desired to slip the buoy.

8.03 SLIPPING A BUOY

(1) When slipping a buoy the reverse of the above procedure is used. After releasing the bridle and stowing, the aircraft is held on the slipline until the engines are started.

(2) Assuming that the above actions have been carried out preparatory to slipping a buoy and that the aircraft is now moored only by the slipline, the only remaining action is to start the engines and cast off. The procedure varies slightly according to the strength and direction of the wind, or proximity of the shoreline, docks, or other obstacles. The pilot should be able to anticipate what the aircraft is going to do immediately the first engine starts and act accordingly. There are several noteworthy points in this respect:

(a) In calm conditions, the aircraft tends to start turning immediately the first engine is started. When this happens one effective method of slipping the buoy is to close haul the buoy along the port bow of the aircraft and start the starboard engine first. The aircraft then swings towards the buoy as it moves forwards. As the buoy passes amidships, the fuselage of the aircraft is turning away from it, and by the time the second engine is started the aircraft should be past the buoy, and the line is cast off.

(b) When the aircraft is in a confined situation, it is sometimes good practice to lengthen the slipline and not slip the buoy until both engines are running. A Canso can circle a buoy indefinitely with both engines idling. The line should be of such a length that the floats are not likely to collide with the buoy.

(c) In strong winds an aircraft can usually be taxied slightly out of wind on one engine. The procedure is to let out ten or fifteen feet of slipline and apply right rudder. This causes the aircraft to swing out of wind slightly. The port engine is then started and the aircraft taxis away on one engine with the buoy passing half way between the hull and the wing tip floats. Then it only remains to cast off the single slipline.

(d) When a buoy is close to a shoreline or dock, it is good practice to first moor the aircraft to a buoy and then work it ashore by the use of lines. The opposite procedure is often effective in working the aircraft away from a dock encumbered by piling and other hazards.

8.04 SUMMARY

(1) A buoy should not be relied on to hold the aircraft unless the anchor is sufficiently heavy. A 15-ton Canso can exert a tremendous pull on a mooring, especially in rough water. Most aircraft buoys are moored with several tons of cement or a cluster of railroad car wheels. Buoys come in several shapes and sizes and not all are equipped with rubber fenders. Solid metal buoys should be approached with caution as a collision would cause damage to the aircraft.

(2) ALL STRANGE BUOYS SHOULD BE APPROACHED WITH CAUTION. Reliable information on the weight of anchors and strength of mooring cables and chains should be obtained if possible. An aircraft should not be left overnight at a mooring unless a crew sufficient to start and taxi the aircraft is left on board.

NOTE: **In all cases of leaving a buoy great care must be exercised to ensure the slipline is not thrown into the arc of the propeller.**

CHAPTER 9

SLIPWAY AND RAMP PROCEDURE

9.01 GENERAL

(1) Before using a slipway or ramp, it is necessary to ensure that it can safely carry the weight of the aircraft. Most slipways in use in Canada were built during the Second World War and have had little or no maintenance since. Some are badly eroded at the sides and can support a heavy aircraft only in the central part. Others have holes and obstructions at the extreme lower end and are unusable during low tides.

(2) The only satisfactory way to inspect a slipway is visually from the ground at the lowest tide. As much information as possible should be gleaned from local sources concerning its construction and the type of aircraft which have been using it recently.

9.02 APPROACHING A SLIPWAY

(1) If the slipway is safe, the approach should be made as slowly as possible with the wheels down and locked. Plenty of time should be allowed the crewmen to check the undercarriage before the aircraft is committed to the approach.

(2) If the approach is made into wind, drogues are not necessary. If made other than into wind particularly downwind, it may be necessary to stream both drogues in order to maintain control at a low speed. The drogues need not be pulled in until the aircraft is safely up the ramp: they drag harmlessly on the ground. In conditions of severe crosswind, it is sometimes necessary to stream one or two drogues from one side only. Care should be taken in using this procedure, because if too much drag is put on one side too much throttle may have to be used to keep straight, cancelling out the slowing effect of the drogues as the aircraft approaches the lee of the shore.

(3) The rudder lock should be cracked in order that the rudders may be locked immediately both main wheels are on the slipway. Use of the brakes may be needed to keep the aircraft straight while generous throttle is applied to taxi up the slipway.

9.03 DEPARTING FROM A SLIPWAY

(1) The slipway descent should be negotiated as slowly as possible. Coasting down a slipway fast can often cause damage to the rear of the hull, as the aircraft's nose rises suddenly on hitting the water.

(2) As the aircraft enters the water, it is often difficult to maintain the same course as that held down the centre of the slipway, so there is a small chance that one of the aircraft wheels may go off the side of the slipway. This can be prevented by setting a compass or gyro while the slipway is in plain sight. The tendency of inexperienced pilots on entering the water and before coming "waterborne", is to veer to the left. The reason for this is not known, but it is suspected that the average pilot has been following the left hand edge of the ramp with his eye, and when that disappears he veers over to the left in order to relocate it. The only way in which a pilot could locate the edge of the slipway would be to run the port wheel off the edge. This is obviously not much of a solution, so the setting of gyros is recommended.

(3) When taxiing down the ramp, the rudders should be left locked, but cracked in order that the rudder pedals may be freed from the moment the aircraft is afloat.

(4) The undercarriage should not be raised until the pilot is sure that he is, in fact, afloat, and that the wheel wells are free of debris.

(5) To prevent seaweed and other floating debris from becoming lodged in the nose wheel doors, care should be taken not to taxi through masses of seaweed after departing from the slipway. When on the approach this is not so important as all debris can be removed from the nose wheel doors when the aircraft is out of the water.

(6) If the aircraft has been stopped after coming up a slipway, a complete external examination should be carried out before re-entering the water. More than one Canso has been lost on entering the water owing to the tunnel hatch being unlocked.

CHAPTER 10

ANCHORING

10.01 GENERAL

(1) The Canso anchor, a folding one made of aluminum alloy, weighs approximately 30 pounds. It is, of necessity, light, and should not be used if other suitable moorings are available. The anchor is stowed in the port side of the nose and access to it may be gained from outside the aircraft. The anchor winch is operated from inside the aircraft; at least two crewmen are required; one outside with the anchor, and the other inside to operate the winch.

(2) The anchor cable is 150 feet in length, wound on a drum inside the aircraft. If this drum is allowed to spin freely during an anchoring, the cable is almost sure to become fouled. Care must be taken to prevent fouling as it may take hours to untangle.

(3) When selecting an anchorage, the following factors should be considered:

(a) the shelter afforded;

(b) the swinging space available;

(c) the strength of the wind and tide;

(d) the distance from the lee shore;

(e) the depth of water and range of tide;

(f) the type of holding ground (bottom); and

(g) the presence of mooring or telegraph cables on the bottom.

10.02 LAYING AN ANCHOR

(1) The aircraft is taxied slowly up to the selected anchorage. The anchor is then let go, and cable equal to at least three and, if possible, five times the depth of the water is paid out while the aircraft is drifting astern. As the anchor holds, beam bearings should be taken so that dragging can be immediately detected.

(2) In calm weather when the aircraft does not give sufficient pull for the anchor to be buried, the aircraft is taxied slowly downwind and the anchor let go with a length of cable. As soon as the anchor holds, the aircraft is brought to a stop by the anchor now

well entrenched. The engines can then be cut and the aircraft drifts round into wind and lies to the anchor. Care must be taken not to carry out this manoeuvre at speed, otherwise the cable or anchor may be strained or broken.

10.03 WEIGHING ANCHOR

(1) When weighing anchor, the cable is winched in until it is vertical. The engines may be required to assist in this process; if not, they should now be started. After a turn of the cable around the bollard the aircraft is taxied forward. This breaks out the anchor which can then be winched up and stowed.

10.04 PREVENTING AN ANCHOR FROM DRAGGING

(1) When an anchor drags, the first thing to do is to let out more cable. Whilst doing this, it is advisable to allow the aircraft to drift back quickly and then make fast the cable so that it is brought to suddenly. This helps to bury the fluke, besides making the pull more horizontal. If this has no effect, sometimes a heavy weight attached well down the cable may act as a shock absorber in rough weather and may also help to make the cable lie horizontally nearer the sea bed.

(2) If the aircraft is going to be anchored for any length of time, or if the water is rough, the anchor cable should be attached to the bridle by means of the clamp. The cable should be paid out from the drum until all tension is off the drum and the aircraft weight is on the bridle. Under certain circumstances, a few turns around a bollard may be made to create the same effect; but this is harder on the aircraft since the bollards are not designed to take as much strain as the bridle and mooring ring.

CHAPTER 11

OPERATING FROM RIVERS

11.01 GENERAL

(1) Taking off, alighting, and operating on rivers are operations demanding skill. Rivers are generally muddy and contain shifting sandbars; since the pilot is unable to distinguish the shallow water from the air, he is taking a chance in landing unless he is absolutely sure of the depth of the water.

11.02 EFFECT OF CURRENT AND WIND

(1) Currents are often strong and create an additional problem for a pilot attempting to moor, dock, beach, or even taxi. A current has a much greater effect on an aircraft than a wind of the same speed. Therefore, during light wind conditions, it is an advantage to take off down current. Taking off down a 10 k current gives an advantage of 20 k over an up current take-off. Similarly, landing against the current gives a shorter landing run.

(2) An approach to a dock, beach or mooring should always be made up current except when there are exceptionally strong winds. If in doubt, the pilot should taxi parallel to the bank in both directions to test for himself which direction gives the slowest approach and the greatest control.

(3) Crosswind conditions are common and pilots should be proficient in crosswind techniques before operating from rivers. After take-off, the river should be followed until sufficient height has been gained. Flying low over the bush should be avoided as turbulence is often severe.

11.03 OBSTRUCTIONS AND HAZARDS

(1) During springtime, extra precautions must be taken because of floating debris. An area free of debris can be found around the bend of a river because the current usually sweeps the debris over to the far bank. Similarly, deep water is more often found on the outside of a bend in the river where the banks are steeply cut, rather than on the inside of the bend where the current is lighter and where sediment is dropped out of the water. Steep banks usually indicate deep water, whereas wide beaches quite often indicate shallow water and shifting sandbars.

(2) Rivers often have power lines crossing them. This constitutes probably the biggest single hazard in river operations. A careful watch should be kept for any type of construction on either river bank. The cables are always invisible until it is too late to avoid them, but the pylons and towers are usually easy to see. At the first sight of anything resembling a tower, the pilot should suspect a cable, even if he cannot see one, and pull up.

(3) Muddy bottoms often hamper beaching operations. If it is suspected that the bottom is muddy, the nose wheel door should be closed and locked, otherwise it becomes full of mud and debris and becomes impossible to close prior to take-off.

OPERATING INSTRUCTIONS - CANSO 2SR and 2F

This section is intended to complement the Engineering Order in outlining in greater detail checks and procedures in use at this unit. Since Canso aircraft have been greatly modified since the Second World War and are still being modified from time to time, it follows that instrumentation and installation of ancillary equipment are not always the same in any two aircraft. While this non-standardization is regrettable and, in some cases, constitutes a minor annoyance, it in no way absolves a pilot from carrying out a complete and thorough check of each individual aircraft to ensure familiarity with the arrangement of switches, instruments, and all other gauges and controls.

NOTE: Refer to EO 60A-1 (Pilot's Operating Instructions).
Also Canso Aircrew Training Manual:
Section 2A-1) Engine Operating Limitations
2A-5)

Section 1E-6 - Sperry Automatic Pilot

NORMAL LAND AND WATER OPERATION

(a) PRE-FLIGHT CHECK - EXTERNAL (Pilot and Flight Engineer)

Commencing at port blister and working forwards around the aircraft:

(1) JATO brackets.
(2) Drift recorder hatch.
(3) Hull (loose rivets, rippling, damage by obstructions).
(4) Under surface of port mainplane.
(5) Aerials.
(6) Port undercarriage well and undercarriage assembly.
(7) Port undercarriage locking device.
(8) Port undercarriage oleo extension.
(9) Port tire (condition, creep, valve stem).
(10) Fire extinguisher indicator.
(11) Port engine nacelle (oil leaks, cowlings, Dzus fasteners).
(12) Pitot head cover removed.
(13) Navigation lights.
(14) De-icer boots.
(15) Landing lights.
(16) Hull (as in (3)).
(17) Port nose wheel door (security of attachment, signs of rippling on rear edge).
(18) Nose wheel well (lock).
(19) Nose oleo (extension - condition of scissors).
(20) Nose wheel tire (condition, creep, valve stem).
(21) Anchor hatch secure - lizard in position.
(22) Starboard nose wheel door (as in (18)).
(23) Hull (as in (3)).
(24) Starboard engine (as in (11)).
(25) Starboard undercarriage well and undercarriage assembly.
(26) Starboard undercarriage locking device.
(27) Starboard oleo extension.
(28) Starboard tire (as in (9)).
(29) Under surface of starboard mainplane.
(30) Aerials.
(31) Navigation lights, de-icer boots, landing lights.
(32) JATO brackets.
(33) Port flare chute secure.
(34) Hull (as in (3)).
(35) Tunnel hatch secure.
(36) Under surface of tailplane.

(37) Underboard flare chute secure (if in operation).
(38) Upper surface of tailplane.
(39) Upper surface of fuselage.
(40) Upper surface of mainplanes, engine nacelles (gas filler caps and oil filler caps secure and locked).

(b) PRE-FLIGHT CHECK - INTERNAL (Pilot, Flight Engineer)

(1) Tunnel Compartment - Tunnel hatch closed and locked. Stowage position of flares, ropes, drogues, portable engine stands. No loose equipment to foul control cables aft.

(2) Blister Compartment - Perspex panels in blisters (security of slide tracks in freighter versions). Very pistol and cartridges, dinghies, forced landing instructions, boat hook, fire extinguisher on rear wall, freight.

(3) Main Cargo Compartment - Sleeping bags and emergency equipment, ration and basic kits, Gibson Girl, first aid kit, freight.

(4) Engineer's Compartment - Flight Engineer checks de-icer fluid tank (contents), APU; main wheel manual lowering lever, main wheel inspection panels locked, main wheel locks (manual); and stowage of: his gear, engine hand crank, crank for anchor and floats, main fire extinguisher bottle.

(5) Radio Operator's Compartment - Fire extinguisher on rear wall, and on radio equipment rack; top hatch closed and locked; the stowage of nose wheel lowering lever (sabre bar), control lock, freight. When the APU is started, the flight engineer switches on main distribution panel as required.

(6) Nose Compartment - Buoy hook and lines in place, no loose ropes or equipment to foul rudder controls or nose door locking pin lever, top hatch must be dogged down and secure.

(c) TARMAC COCKPIT CHECK

According to Standard Operating Procedures.

(d) CHALLENGE PRE-START CHECK (Pilot, Co-pilot, Flight Engineer)

According to Unit Check List for Canso Aircraft.

(e) ENGINE STARTING (Pilot and Flight Engineer)

Pilot:

(1) When ready, designates engine to be started first.
(2) Master switch ON.
(3) Answers CONTACT to Flight Engineer and turns magneto switches ON.
(4) Idles engines 800-1000 rpm. If engine floods, opens throttle wide with switch ON, being prepared to return throttle to IDLE position immediately engine fires. If engine fails to start, notifies Flight Engineer SWITCHES OFF. Since starter dog will probably not disengage it will be necessary to back off the propeller approximately 1/4 turn to disengage the starter mechanism. In very cold weather if the engine sputters and misses but continues to fire, carb heat may be used to assist the start. (This serves to vaporize the fuel and creates a more even charge in the cylinder).

Flight Engineer:

(1) Engines hand turned.
(2) Primes engines as required. Fire extinguisher turned to engine to be started.
(3) Energizes engine starter on designated engine.
(4) Calls CONTACT before meshing starter.
(5) When engine fires, puts mixture control in AUTO RICH.
(6) Notifies pilot immediately of any fault noticed in running. If engine stops, returns mixture control to IDLE CUT-OFF immediately.
(7) Generator switches ON.

NOTE

(i) Crewman with hand fire extinguisher must be in position aft of trailing edge of mainplane, standing on top of fuselage during all operations.

(ii) Starter may fail to energize. If this happens, the engine may be started by having a crewman hand crank the engine. If this operation is carried out, the pilot must idle the engine until the crewman is clear of the wing. The crewman must be cautioned about hot exhaust gases.

(iii) The starter may fail to mesh although it energizes. The engine may be started by having a crewman hand engage the starter.

(f) PRE TAXI CHECK - CHALLENGE (Pilot, Co-pilot, Flight Engineer)

According to Unit Check List for Canso Aircraft.

(g) PRE RUN-UP CHECK - CHALLENGE (Pilot, Co-pilot, Flight Engineer)

According to Unit Check List for Canso Aircraft.

(h) RUNNING UP ENGINES (Pilot, Flight Engineer)

(1) Throttles set at IDLE.
  (i) Live magneto - master switch.
  (ii) Dead magneto.
(2) Starboard engine opened to 1800 rpm.
(3) Pitch control is operated through full travel (twice):
  (i) Generators should cut in at approximately 1500 rpm.
  (ii) Rpm should fall at least 600 rpm.
(4) While operating pitch control pilot calls flight engineer for carb heat check.
(5) Feathering button is operated (first run-up of day). When rpm falls 100-200 rpm button is pulled out. Rpm should return to original figure.
(6) Mag switches are checked (preliminary check only).
(7) Throttle is advanced to 48" MP - 2700 rpm.
(8) Throttle is returned to 30" MP.

(9) Magneto switches are checked (on testing magnetos, operations are called to flight engineer, i.e., LEFT MAG - BOTH MAGS - RIGHT MAG, etc., on intercom).

(10) Engine throttled back to check idling rpm. (500-600 rpms for water work, otherwise 600-700 rpm).

(j) PRE TAKE-OFF CHECK - CHALLENGE (Pilot, Co-pilot, Flight Engineer)

According to Unit Check List for Canso Aircraft.

(k) POST TAKE-OFF CHECK - CHALLENGE (Pilot, Co-pilot, Flight Engineer)

According to Unit Check List for Canso Aircraft.

(l) PRE-LANDING CHECK - CHALLENGE (Pilot, Co-pilot, Flight Engineer)

According to Unit Check List for Canso Aircraft.

(m) POST-LANDING CHECK - CHALLENGE (Pilot, Co-pilot, Flight Engineer)

According to Unit Check List for Canso Aircraft.

(n) STOPPING ENGINES (Pilot and Flight Engineer)

(1) Brakes ON on land; securely moored, beached or docked on water.
(2) R/T check with flight engineer.
(3) Throttles set at 1000 rpm.
(4) Pitch FULL FINE.
(5) When cylinder head temperature falls below 200 degrees C, STOP ENGINES signalled.

(o) STOPPING ENGINES (Flight Engineer)

(1) Engine temperatures checked (if not at required temperature pilot should be informed).
(2) Oil dilution if and when required.
(3) IDLE CUT OFF when signalled.
(4) Floats DOWN on land, if signalled. (First he must ensure that the generator is charging).
(5) Cowl gills open.

(p) POST SHUT-DOWN CHECK - CHALLENGE (Pilot and Co-pilot)

According to Unit Check List for Canso Aircraft.

(q) POST SHUT-DOWN CHECK (Flight Engineer)

(1) Brakes ON on land; securely moored, beached or docked on water.
(2) Magneto and master switches OFF.
(3) Internal control locks ON.
(4) Rudder lock ON.
(5) All windows and hatches CLOSED.
(6) Pitot head cover on and tail bar in place.
(7) Wheel locks in place on land.
(8) Wheel chocked on land.
(9) Aircraft locked (when applicable).

(r) OIL DILUTION

Refer to Section 2D-1 Canso Aircrew Training Manual

APPENDIX "B"
to Canso Flying Manual

FEATHERING PROCEDURES AND SINGLE ENGINE HANDLING

(a) ENGINE FAILURE IN FLIGHT - ACTUAL (Pilot and Flight Engineer)

(1) Control aircraft (trim, height, direction, safety speed)
(2) Mixture (auto-rich on both)
Pitch (as required - 2300 rpm to 2550 rpm depending on load)
Throttles (as required - 35" MP to 41" MP depending on load).
(3) Trim - cockpit and drag check (suction: wheels and floats up, trailing aerial, etc.).
Cockpit check with flight engineer to ascertain cause of trouble.
(4) Throttle back and pitch coarse on dead engine (safety check - this ensures that live engine is not feathered).
(5) Feather dead engine.
(6) Switches off dead engine.
(7) Cockpit check with flight engineer (Flight engineer reports mixture in idle cut-off, gills closed and fire extinguisher selected).
(8) Pitch and power settings adjusted as required.

(b) ENGINE FAILURE IN FLIGHT - SIMULATED (Pilot and Flight Engineer)

The flight engineer is first notified of intention and must be ready to place mixture in idle cut-off after the engine is feathered. Simulate engine failure by throttling back. The procedure is similar to that in (a) except in handling of throttles and pitch control.

(1) Control aircraft (trim, height, direction, safety speed)
(2) Mixture (auto-rich on both)
Pitch (2300 rpm on live engine)
Throttle (35" MP on live engine)
(3) Trim as necessary. (Cockpit and drag check, suction, wheels up, floats up, trailing aerial, etc).
(4) Pitch back on dead engine (assists feathering action).
(5) Feather dead engine.
(6) Cockpit check with flight engineer (flight engineer reports mixture idle cut-off, gills closed and fire extinguisher selected).
(7) Switches off dead engine.
(8) Pitch and power settings adjusted as required.

(c) UNFEATHERING IN FLIGHT (Pilot and Flight Engineer)

If the engine has been feathered because of some fault, e.g., over-heating, low oil pressure, etc., it should be unfeathered only under very special circumstances. Unfeathering a faulty engine to aid in landing is invariably more hazardous than making a single engine landing.

(1) Throttles are set to starting position.
(2) Pitch control is set just forward of minimum rpm.
(3) Switches ON.
(4) Feathering button is pressed and held in until 800 rpm is reached, then released.
(5) Fuel supply is selected - mixture AUTO-RICH.
(6) Fuel pressure is built up with wobble pump if necessary.
(7) Engine must be warmed up slowly before increasing power and rpm. The pilot keeps a constant check, with the flight engineer, on temperatures and pressures.

(d) SINGLE ENGINE HANDLING (Pilot)

(1) Safety speed 80 k to 85 k (EO 06-60A-1).
(2) Single engine speed 85 k to 90 k. Each aircraft must be checked for its capabilities.
(3) Critical speed approximately 75 k.

FLOAT OPERATION

The wing tip floats are electrically operated normally, but there is an emergency hand crank in the flight engineer's position. A two speed gear system is incorporated for manually raising or lowering the floats. The float motor causes a heavy drain on the batteries so both engine generators must be charging fully before any attempt is made to raise or lower the floats.

If the floats have been lowered on land to tie down overnight, they may be hand cranked up, or both throttles may be opened up enough for the generators to be cut in (1500 rpm) and the floats raised normally. They are to be raised before take-off on land; with floats down the airspeed is reduced by approximately 5k and aileron control is appreciably reduced.

TAXIING

(a) TAXIING ON LAND

(1) The maximum turn angle of the nose wheel is 30 degrees. The scissors which limit its movement could be broken by the stress of a sharp turn. Another reason for avoiding this manoeuvre is that on rough ground or loose gravel it can cause creeping of the nose wheel tire, resulting in the shearing off of the valve stem.

(2) The aircraft should be in forward motion and the nose wheel castoring before any attempt is made to turn, and no attempt should be made to force a turn against the lie of the nose wheel. It is therefore advisable, when leaving a parking position, to test the brakes for positive action, and then to make any desired turn. Turns should never be made on a locked inside main wheel.

(3) Taxiing should be done with a minimum of brake. Care must be exercised when applying brakes otherwise they may overheat, or produce a lurching movement throwing an excessive load on the nose wheel tire. Dual brakes are provided, but because of the differential linkage system only one pilot can apply brake at one time.

(4) Use of the rudder lock in taxiing is left to the pilot's discretion. If fairly calm conditions exist, the aircraft can be easily controlled by rudder and engines; however in moderate to strong wind conditions the rudder should be locked.

(b) TAXIING ON WATER

(1) Taxiing should be kept to a minimum.

(2) Care must be taken to avoid overheating the engines, and to prevent water spray damage to engines and propellors.

(3) The taxiing speed should be kept low without prolonged idling of the engines. This is achieved by keeping the nose as high as possible and by using drogues to the fullest reasonable extent.

(4) The undercarriage may be used for its drogue effect, particularly in rough water handling. Before it is lowered taxi speed must be reduced to the lowest possible to allow the nose wheel to lock down. The undercarriage must be down and locked before grounding.

(5) At all times care must be taken to prevent damage to the undercarriage or nose wheel doors when down in the water.

CHECK LISTS

(a) PRE-START CHECK - CANSO AIRCRAFT

CHALLENGE (Co-Pilot)		REPLY (Captain)	
1.	L14, F17, Wt & Balance, Manifest, Flight Plan, Customs	1.	"Completed"
2.	External Check	2.	"Completed"
3.	Internal Check	3.	"Completed"
4.	Flight Compartment	4.	"Completed"
5.	Parking Brakes - Hydraulic Pressure	5.	"On - 1000 Lbs"
6.	Master Switch - Magnetos	6.	"On - Off"
7.	Propeller Anti-Icers	7.	"Checked"
8.	Pitch	8.	"Full Fine"
9.	Throttles	9.	"Cracked"
10.	Intercom & Signal Lights	10.	"Checked"
11.	Fire Guard		
12.	Flight Engineer - Start APU - Pre-Start Check		

(b) FLIGHT ENGINEER'S PRE-START CHECK LIST

1. Engines Hand Turned, Strainers Drained
2. Battery Master Switch "On", APU Operating
3. Gills "Open"
4. Gas "On Both"
5. Oil Contents Checked .... Gals
6. Carburettor Heat "Cold"
7. Mixture "Idle Cut Off"
8. Engines Primed, Ready to Start

(c) PRE-TAXI CHECK

CHALLENGE (Co-Pilot)		REPLY (Captain)	
1.	Radios	1.	"On"
2.	Gyros	2.	"Set"
3.	Flight Engineer - Pre-Taxi Check		

(d) FLIGHT ENGINEER'S PRE-TAXI CHECK LIST

1. Chocks, Locks, Tail Bar, Ladder in and Stowed.
2. Pitot Cover Removed
3. Hatches Closed and Secure
4. Electrical Panel Checked - Switches On
5. Passengers in Position (If Necessary)
6. Temperatures and Pressures Normal for Taxiing

(e) PRE RUN-UP CHECK

CHALLENGE (Co-Pilot)	REPLY (Captain)
1. Parking Brakes	1. "Set"
2. Mixture	2. "Auto Rich"
3. Pitch	3. "Full Fine"
4. Clearance behind	4. "Checked"
5. Flight Engineer - Pre Run-Up Check	

(f) FLIGHT ENGINEER'S PRE RUN-UP CHECK LIST

1. Gills "Adjusted"
2. Mixture "Auto Rich"
3. Crossfeed Checked - Fuel Selectors "On Both"
4. Carburettor Heat "Cold"
5. Temperatures and Pressures Normal for Run-Up

(g) PRE TAKE-OFF CHECK

CHALLENGE (Co-Pilot)	REPLY (Captain)
1. Hydraulics - U/C Chain	1. "Checked-Unhooked"
2. Hatches	2. "Secure"
3. Harness	3. "Secure"
4. Trim Tabs	4. "Set"
5. Tension	5. "Set"
6. Mixture	6. "Auto Rich"
7. Carburettor Heat	7. "Cold"
8. Pitch	8. "Full Fine"
9. Floats	9. "Up or Down and Locked"
10. Gyros	10. "Set"
11. Auto Pilot	11. "Off"
12. Magnetos	12. "On"
13. Pitot Heat	13. "On"
14. Controls and Rudder Lock	14. "Checked & Off"
15. Take-Off Briefing	
16. Flight Engineer - Pre Take-Off Check	

(h) FLIGHT ENGINEER'S PRE TAKE-OFF CHECK LIST

1. Seat Belts Secure
2. Hatches Secure
3. Temperatures and Pressures Normal
4. Mixture "Auto Rich"
5. Carburettor Heat "Cold"
6. Full "On Both" .... Gals
7. Floats "Up" (or Down)
8. Gills "Open"
9. Water Check Carried Out (only for water take-off)
10. Ready for Take-Off

(j) POST TAKE-OFF CHECK

CHALLENGE (Co-Pilot)	REPLY (Captain)
1. Undercarriage (or Floats)	1. "Up"
2. Flight Engineer - Post Take-Off Check	

(k) FLIGHT ENGINEER'S POST TAKE-OFF CHECK LIST

1. "Temperatures & Pressures Normal Undercarriage (or Floats) Up and Locked"

(l) PRE LANDING CHECK

CHALLENGE (Co-Pilot)	REPLY (Captain)
1. Brakes	1. "Off"
2. Undercarriage (or Floats)	2. "Up or Down, Lights Check"
3. Mixture	3. "Auto Rich"
4. Pitch	4. "Adjusted"
5. Flight Engineer - Pre Landing Check	

(m) FLIGHT ENGINEER'S PRE LANDING CHECK LIST

1. Cabin Heater "Off"
2. Fuel on Both .... Gals
3. Mixture "Auto Rich"
4. Carburettor Heat "Cold"
5. Undercarriage (or Floats) "Down and Locked" (Water Check Carried Out)
6. Passengers "Secure" (if applicable)
7. Temperatures and Pressures "Normal"
8. Secure for Wheel (Water) Landing

(n) POST LANDING CHECK

CHALLENGE (Co-Pilot)	REPLY (Captain)
1. Undercarriage Chain	1. "Secure"
2. Mixture	2. "Auto Lean"
3. Pitch	3. "Full Fine"
4. Pitot Heat	4. "Off"
5. Rudder Lock	5. "On"
6. Radios (unessential)	6. "Off"
7. Flight Engineer - Post Landing Check (Water Only)	

(o) FLIGHT ENGINEER'S POST LANDING CHECK LIST

1. "Water Check Carried Out"

(p) AFTER SHUT-DOWN CHECK

CHALLENGE (Co-Pilot)	REPLY (Captain)
1. Brakes	1. "As Required"
2. Throttles	2. "Open"
3. Switches	3. "Off"
4. Gyros	4. "Caged"
5. Radios & IFF	5. "Off"
6. Lights	6. "Off"
7. Undercarriage Indicator Light	7. "Off"