SEAPLANE, SKIPLANE, and FLOAT/SKI EQUIPPED HELICOPTER OPERATIONS HANDBOOK

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U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION
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Chapter 8

Emergency Open Sea Operations

OPERATIONS IN OPEN SEAS

Open sea operations are very risky and should be avoided if possible. If an open sea landing cannot be avoided, a thorough reconnaissance and evaluation of the conditions must be performed to ensure safety. The sea usually heaves in a complicated crisscross pattern of swells of various magnitudes, overlaid by whatever chop the wind is producing. A relatively smooth spot may be found where the cross swells are less turbulent. Both a high and a low reconnaissance are necessary for accurate evaluation of the swell systems, winds, and surface conditions.

DEFINITIONS

When performing open sea operations, it is important to know and understand some basic ocean terms. A thorough knowledge of these definitions allows the pilot to receive and understand sea condition reports from other aircraft, surface vessels, and weather services.

Fetch—An area where wind is generating waves on the water surface. Also the distance the waves have been driven by the wind blowing in a constant direction without obstruction.

Sea—Waves generated by the existing winds in the area. These wind waves are typically a chaotic mix of heights, periods, and wavelengths. Sometimes the term refers to the condition of the surface resulting from both wind waves and swells.

Swell—Waves that persist outside the fetch or in the absence of the force that generated them. The waves have a uniform and orderly appearance characterized by smooth, regularly spaced wave crests.

Primary Swell—The swell system having the greatest height from trough to crest.

Secondary Swells—Swell systems of less height than the primary swell.

Swell Direction—The direction from which a swell is moving. This direction is not necessarily the result of the wind present at the scene. The swell encountered may be moving into or across the local wind. A swell tends to maintain its original direction for as long as it continues in deep water, regardless of changes in wind direction.

Swell Face—The side of the swell toward the observer. The back is the side away from the observer.

Swell Length—The horizontal distance between successive crests.

Swell Period—The time interval between the passage of two successive crests at the same spot in the water, measured in seconds.

Swell Velocity—The velocity with which the swell advances in relation to a fixed reference point, measured in knots. (There is little movement of water in the horizontal direction. Each water particle transmits energy to its neighbor, resulting primarily in a vertical motion, similar to the motion observed when shaking out a carpet.)

Chop—A roughened condition of the water surface caused by local winds. It is characterized by its irregularity, short distance between crests, and whitecaps.

Downswell—Motion in the same direction the swell is moving.

Upswell—Motion opposite the direction the swell is moving. If the swell is moving from north to south, a seaplane going from south to north is moving upswell.

SEA STATE EVALUATION

Wind is the primary cause of ocean waves and there is a direct relationship between speed of the wind and the state of the sea in the immediate vicinity. Windspeed forecasts can help the pilot anticipate sea conditions. Conversely, the condition of the sea can be useful in determining the speed of the wind. Figure 8-1 on the next page illustrates the **Beaufort wind scale** with the corresponding **sea state condition number**.

While the height of the waves is important, it is often less of a consideration than the wavelength, or the distance between swells. Closely spaced swells can be very violent, and can destroy a seaplane even though the wave height is relatively small. On the other hand, the same seaplane might be able to handle much higher waves if the swells are several thousand feet apart. The relationship between the swell length and the height of

BEAUFORT WIND SCALE WITH CORRESPONDING SEA STATE CODES

Beaufort Number	Wind Velocity (Knots)	Wind Description	Sea State Description	Sea State: Term and Height of Waves (Feet)	Sea State: Condition Number
0	Less than1	Calm	Sea surface smooth and mirror-like	Calm, glassy 0	0
1	1-3	Light Air	Scaly ripples, no foam crests		
2	4-6	Light Breeze	Small wavelets, crests glassy, no breaking	Calm, rippled 0 – 0.3	1
3	7-10	Gentle Breeze	Large wavelets, crests begin to break, scattered whitecaps	Smooth, wavelets 0.3-1	2
4	11-16	Moderate Breeze	Small waves, becoming longer, numerous whitecaps	Slight 1-4	3
5	17-21	Fresh Breeze	Moderate waves, taking longer form, many whitecaps, some spray	Moderate 4-8	4
6	22-27	Strong Breeze	Larger waves, whitecaps common, more spray	Rough 8-13	5
7	28-33	Near Gale	Sea heaps up, white foam streaks off breakers	Very rough 13-20	6
8	34-40	Gale	Moderately high, waves of greater length, edges of crests begin to break into spindrift, foam blown in streaks		
9	41-47	Strong Gale	High waves, sea begins to roll, dense streaks of foam, spray may reduce visibility		
10	48-55	Storm	Very high waves, with overhanging crests, sea white with densely blown foam, heavy rolling, lowered visibility	High 20-30	7
11	56-63	Violent Storm	Exceptionally high waves, foam patches cover sea, visibility more reduced	Very high 30-45	8
12	64 and over	Hurricane	Air filled with foam, sea completely white with driving spray, visibility greatly reduced	Phenomenal 45 and over	9

Figure 8-1. Beaufort wind scale.

the waves is the **height-to-length ratio** [Figure 8-2]. This ratio is an indication of the amount of motion a seaplane experiences on the water and the threat to capsizing. For example, a body of water with 20-foot waves and a swell length of 400 feet has a height-to-length ratio of 1:20, which may not put the seaplane at risk of capsizing, depending on the crosswinds.

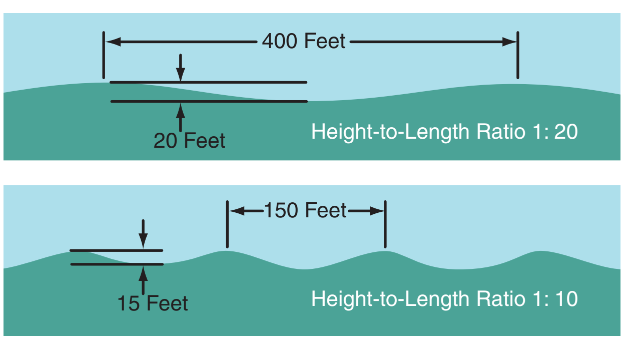

Figure 8-2. Height-to-length ratio.

However, 15-foot waves with a length of 150 feet produce a height-to-length ratio of 1:10, which greatly increases the risk of capsizing, especially if the wave is breaking abeam of the seaplane. As the swell length decreases, swell height becomes increasingly critical to capsizing. Thus, when a high swell height-to-length ratio exists, a crosswind takeoff or landing should not be attempted. Downwind takeoff and landing may be made downswell in light and moderate wind; however, a downwind landing should never be attempted when wind velocities are high regardless of swell direction.

When two swell systems are in phase, the swells act together and result in higher swells. However, when two swell systems are in opposition, the swells tend to cancel each other or "fill in the troughs." This provides a relatively flat area that appears as a lesser concentration of whitecaps and shadows. This flat area is a good touchdown spot for landing. [Figure 8-3]

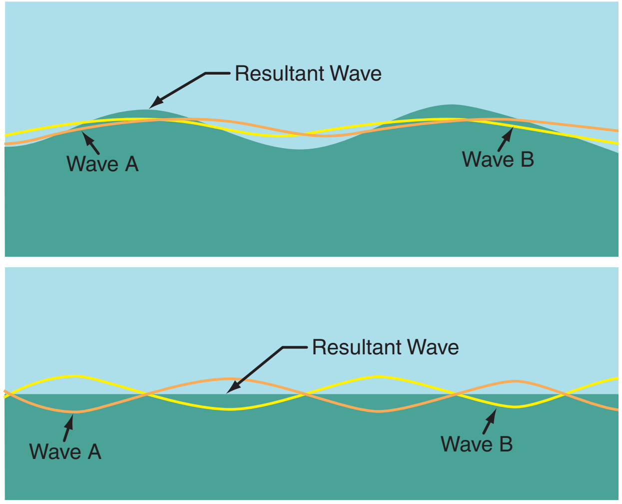

Figure 8-3. Wave interference.

SWELL SYSTEM EVALUATION

The purpose of the swell system evaluation is to determine the surface conditions and the best heading and technique for landing. Perform a high reconnaissance, a low reconnaissance, and then a final determination of landing heading and touchdown area.

HIGH RECONNAISSANCE

During the high reconnaissance, determine the swell period, swell velocity, and swell length. Perform the high reconnaissance at an altitude of 1,500 to 2,000 feet. Fly straight and level while observing the swell systems. Perform the observation through a complete 360º pattern, rolling out approximately every 45º.

Fly parallel to each swell system and note the heading, the direction of movement of the swell, and the direction of the wind.

To determine the time and distance between crests, and their velocity, follow these directions:

1. Drop smoke or a float light and observe the wind condition.
2. Time and count the passage of the smoke or float light over successive crests. The number of waves is the number of crests counted minus one. (A complete wave runs from crest to crest. Since the timing starts with a crest and ends with a crest, there is one less wave than crests.) Time and count each swell system.
3. Obtain the swell period by dividing the time in seconds by the number of waves. For example, 5 waves in 30 seconds equates to a swell period of 6 seconds.
4. Determine the swell velocity in knots by multiplying the swell period by 3. In this example, 6 seconds multiplied by 3 equals 18 knots.
5. To determine the swell length or distance between crests in feet, multiply the square of the swell period by 5. For example, using a 6-second swell period, 6^2 multiplied by 5 equals 180 feet. [Figure 8-4]

Swell Period	$\frac{\text{Time in Seconds}}{\text{Number of Waves Counted}}$
Swell Velocity	Swell Period x 3 knots
Swell Length	Swell Period^2 x 5 Feet

Figure 8-4. Rules of thumb to determine swell period, velocity, and length.

LOW RECONNAISSANCE

Perform the low reconnaissance at 500 feet to confirm the findings of the high reconnaissance and obtain a more accurate estimate of wind direction and velocity.

If the direction of the swell does not agree with the direction noted at 2,000 feet, then there are two swell systems from different directions. The secondary swell system is often moving in the same direction as the wind and may be superimposed on the first swell system. This condition may be indicated by the presence of periodic groups of larger-than-average swells.

The wind direction and speed can be determined by dropping smoke or observing foam patches, whitecaps, and wind streaks. Whitecaps fall forward with the wind but are overrun by the waves. Thus, the foam patches appear to slide backward into the direction from which the wind is blowing. To estimate wind velocity from sea surface indications, see figure 8-1.

SELECT LANDING HEADING

When selecting a landing heading, chart all observed variables and determine the headings that will prove the safest while taking advantage of winds, if possible. Descend to 100 feet and make a final evaluation by flying the various headings and note on which heading the sea appears most favorable. Use the heading that looks smoothest and corresponds with one of the possible headings selected by other criteria.

Consider the position of the sun. A glare on the water during final approach might make that heading an unsafe option.

Use caution in making a decision based on the appearance of the sea. Often a flightpath directly downswell appears to be the smoothest, but a landing on this heading could be disastrous.

SELECT TOUCHDOWN AREA

On final approach, select the touchdown area by searching for a null or smooth area in the swell system, avoiding rough areas if possible. When doing so, consider the conditions discussed in the following sections.

LANDING PARALLEL TO THE SWELL

When landing on a swell system with large, widely spaced crests more than four times the length of the floats, the best landing heading parallels the crests and has the most favorable headwind component. In this situation, it makes little difference whether touchdown is on top of the crest or in the trough.

LANDING PERPENDICULAR TO THE SWELL

If crosswind limits would be exceeded by landing parallel to the swell, landing perpendicular to the swell might be the only option. Landing in closely spaced swells less than four times the length of the floats should be considered an emergency procedure only, since damage or loss of the seaplane can be expected. If the distance between crests is less than half the length of the floats, the touchdown may be smooth, since the floats will always be supported by at least two waves, but expect severe motion and forces as the seaplane slows.

A downswell landing on the back of the swell is preferred. However, strong winds may dictate landing into the swell. To compare landing downswell with landing into the swell, consider the following example. Assuming a 10-second swell period, the length of the swell is 500 feet, and it has a velocity of 30 knots or 50 feet per second. Assume the seaplane takes 890 feet and 5 seconds for its runout.

Downswell Landing—The swell is moving with the seaplane during the landing runout, thereby increasing the effective swell length by about 250 feet and resulting in an effective swell length of 750 feet. If the seaplane touches down just beyond the crest, it finishes its runout about 140 feet beyond the next crest. [Figure 8-5]

Landing into the Swell—During the 5 seconds of runout, the oncoming swell moves toward the seaplane a distance of about 250 feet, thereby shortening the effective swell length to about 250 feet. Since the seaplane takes 890 feet to come to rest, it would meet the oncoming swell less than halfway through its runout and it would probably be thrown into the air, out of control. Avoid this landing heading if at all possible. [Figure 8-6]

If low ceilings prevent complete sea evaluation from the altitudes prescribed above, any open sea landing should be considered a calculated risk, as a dangerous but unobserved swell system may be present in the proposed landing area. Complete the descent and before-landing checklists prior to descending below 1,000 feet if the ceiling is low.

LANDING WITH MORE THAN ONE SWELL SYSTEM

Open water often has two or more swell systems running in different directions, which can present a confusing appearance to the pilot. When the secondary swell system is from the same direction as the wind, the preferred direction of landing is parallel to the primary swell with the secondary swell at some angle. When landing parallel to the primary swell, the two choices of heading are either upwind and into the secondary swell, or downwind and downswell. The heading with the greatest headwind is preferred; however, if a pronounced secondary swell system is present, it may be desirable to land downswell to the secondary swell system and accept some tailwind component. The risks associated with landing downwind versus downswell must be carefully considered. The choice of heading depends on the velocity of the wind versus the velocity and the height of the secondary swell. [Figure 8-7]

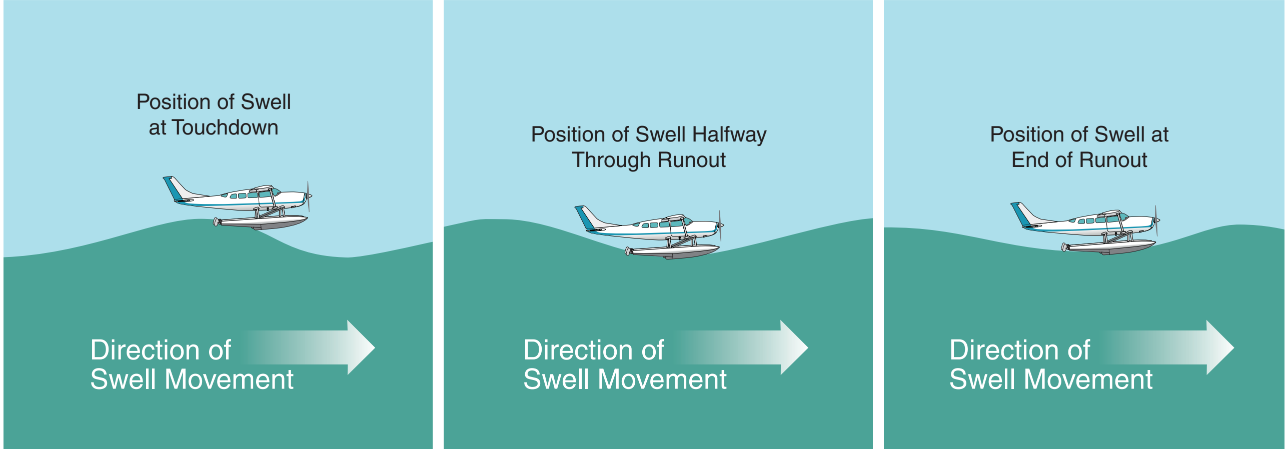

Figure 8-5. Landing in the same direction as the movement of the swell increases the apparent length between swell crests.

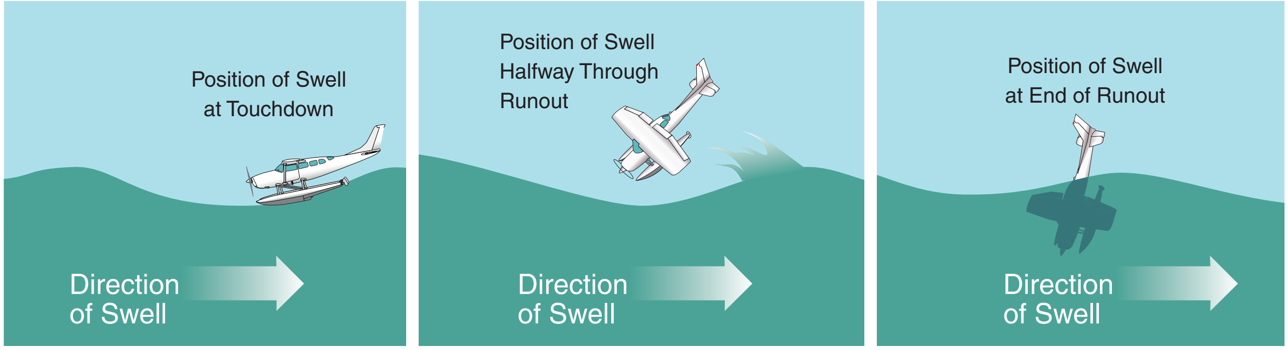

Figure 8-6. Landing against the swell shortens the apparent distance between crests, and could lead to trouble.

Due to the rough sea state, landings should not be attempted in winds greater than 25 knots except in extreme emergencies. Crosswind limitations for each type of seaplane must be the governing factor in crosswind landings.

EFFECT OF CHOP

Chop consists of small waves caused by local winds in excess of 14 knots. These small waves ride on top of the swell system and, if severe, may hide the underlying swell system. Alone, light and moderate chop are not considered dangerous for landings.

NIGHT OPERATIONS

Night landings in seaplanes on open water are extremely dangerous with a high possibility of damage or loss of the seaplane. A night landing should only be performed in an extreme emergency when no other options are available. A night landing on a lighted runway exposes the seaplane to much less risk.

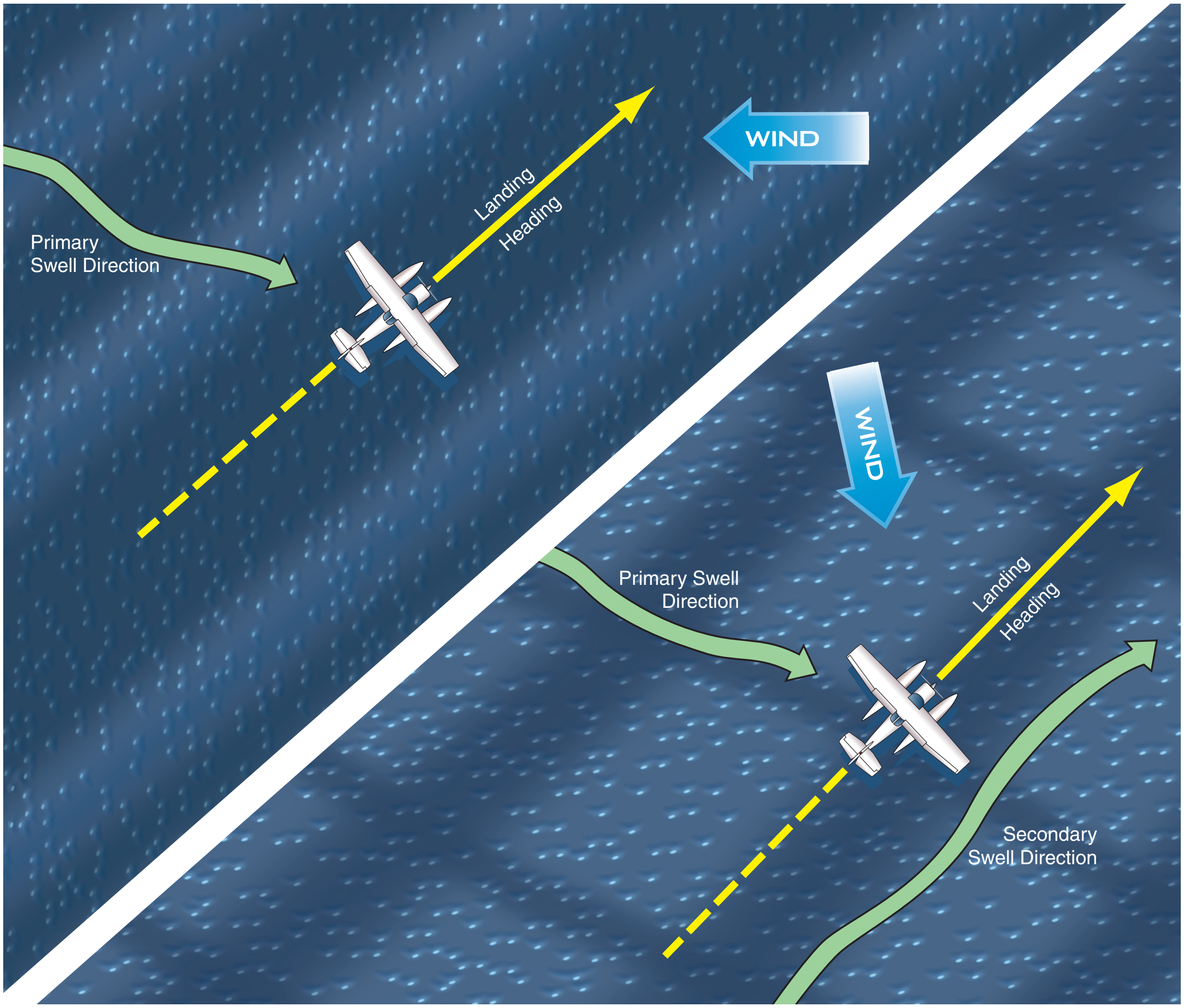

Figure 8-7. Landing heading in single and multiple swell systems.