

II. General Weather, Currents And Tides

The majority of the background information presented here is derived from the National Weather Service and can be viewed in its entirety in the *U.S. Coast Pilot, Pacific Coast*, published by NOAA and available from the following website:

<http://nauticalcharts.noaa.gov/nsd/cpdownload.htm>. The *Coast Pilot* information is augmented with observations from local sources.

Ships traveling into the Bay encounter diverse weather, currents, tides and bottom depths. Because of the often varied and changing set of harbor conditions, mariners must be observant about current conditions to navigate safely.

Weather

Bay Area weather is seasonably variable with three discernible seasons affecting the marine environment. The Bay Area has several climate regimes, or microclimates. Significant differences in temperature, winds, and fog patterns over relatively short distances are due to variations in air mass between land and sea and to the complex terrain of the coastal mountain ranges. Wind direction is generally west to east; however, there is a great deal of variation due to the complex geography.

Because of the many microclimates of the San Francisco Bay Area, mariners who navigate the waters from outside the Golden Gate, through the San Francisco Bay and Delta and into the Central Valley must be aware of how weather conditions can change significantly over short distances and over short periods of time. Mariners must also be aware of the unique weather conditions and weather hazards that are most prevalent during each season.

Winds

Winter. Winter is the season with the most significant seas, both in terms of locally driven wind waves as well as open ocean swells that are generated by long fetches of strong winds over the eastern Pacific. Winter winds from November to February shift frequently and have a wide range of speeds dependent on the procession of offshore high and low pressure systems. Calms occur 15 to 40 percent of the time inside the Bay and 10 to 12 percent outside. Extreme wind conditions of 50 knots gusting to 75 knots have occurred during the winter. The strongest winds tend to come from the Southeast to Southwest ahead of a cold front.

Seas are sometimes large enough to produce breakers across the San Francisco Bar, several miles west of the Golden Gate. These breaking waves in the open ocean present a significant danger to mariners, especially those unfamiliar with the area. Breakers across the bar are most common with a long period westerly swell around the time of maximum ebb current through the Golden Gate.

Spring. Spring is generally the windiest season, with average speeds in the Bay of 6-12 knots, with wind speeds of 17-28 knot winds up to 40 percent of the time. Wind speeds sometimes reach gale force over the coastal waters outside the Golden Gate, and approach gale force locally in northern San Francisco Bay. Wind direction stabilizes as the Pacific High Pressure System becomes the dominant weather influence. Northwesterly winds are generated and reinforced by the sea breeze. Inside the Bay, winds are channeled and vary from Northwest to Southwest.

Strong springtime winds over the coastal waters produce rough and choppy seas with a short period swell. The large long-period swells that are common during the winter months still roll through the coastal waters quite often during the early spring, but taper off considerably by late spring as the storm track across the Pacific becomes less active.

Summer. Summer winds are the most constant and predictable. The winds outside the Golden Gate are normally from Northwest to North and are generated by the strong Pacific High Pressure System. This condition lasts through October until the system weakens and the winter cycle starts again. Winds inside the Bay are local depending on the land contours acting on the onshore flow. One of the few occurrences that will alter this pattern is when a high pressure system settles over Washington and Oregon. When this happens a Northeast flow develops, bringing warm dry air and clearing away the summer fog.

Small craft advisory conditions (20 to 25 knots) occur nearly every day in summer through the central and northern San Francisco Bay and eastward through the Carquinez Strait. Wind speeds sometimes locally reach 30 knots in these areas. Gales are rare in summer, but can occur during an unusually intense onshore push.

During the summer months, seas in the coastal waters are mostly generated from local winds and therefore have a short period and tend to be choppy. Large, long-period swells from the open ocean contribute much less to the overall wave height than during the late fall to early spring time frame.

Safety Considerations in Severe Weather: Large Vessels and Tugs with Tows 1600 Gross Tons or Greater

Extreme wind conditions occasionally require the San Francisco Bar to be closed to vessel traffic. The following best practices apply to large vessels of 1600 gross tons or more and to tows with tugs of 1600 gross tons or more. They are meant to serve as guidelines, and are not meant to relieve the mariner of his or her responsibility to follow applicable rules and regulations addressing prudent seamanship.

Factors to consider when closing the Bar or limiting transits in the Bay. A number of factors must be considered when limiting transits in the Bay or closing the Bar due to severe weather, including sea state, tidal influences, visibility, traffic density, and wind advisories issued by NOAA. The size, class and condition of the vessels being addressed must also be considered. The HSC recommends a tiered approach, applying greater caution as conditions worsen.

Sustained winds exceeding 25 knots in the Bay

- Vessels should closely evaluate whether it is safe to transit in the Bay. Size, class and sail area of the vessel, tidal influences, visibility, and traffic density should all be considered.
- VTS San Francisco will establish regular communications with bridge watches of VTS users in Bay Area anchorages, and more closely monitor swing circles to ensure vessels are not drifting.

Sustained winds exceeding 40 knots in the Bay

- Transits to and from berths are not recommended.

Sustained winds exceeding 40 knots and/or seas exceed 12 ft at the Sea Buoy

- Bar traffic restrictions and closure should be considered. Size and class of the vessel, draft, swell period, tidal influences, visibility, and traffic density should all be considered. Strong ebb tides should be avoided, and a minimum of 10 feet under-keel clearance is recommended.

Procedures for Closing the Bar or Restricting Bar Traffic

- Bar closures are exercised on a situational basis without specifically defined weather or security conditions.

- The most recent San Francisco Bar Pilot over the Bar, inbound or outbound, shall make the recommendation to the dispatcher that the Bar should be considered for closure, or traffic limited to one-way traffic.
- In the event that the station boat is “boarded off,” then the station boat captain will make the recommendation to the dispatcher.
- The dispatcher will then notify the Operations Pilot, who will notify the Port Agent.
- The Operations Pilot or Port Agent will then notify the U.S. Coast Guard VTS and Command Duty Officer at the Sector San Francisco Command Center.
- The Captain of the Port will consult with the Operations Pilot or Port Agent prior to closing the bar under Captain of the Port authority. The Coast Guard will then issue a Marine Safety Broadcast communicating the closure or traffic restriction.
- The procedure for lifting traffic restrictions or re-opening the Bar will be the same as that for restricting traffic or closing the Bar.
- Vessels under Federal Pilotage or Public Vessel may petition the Captain of the Port to transit the San Francisco Bar.

Safety Considerations in Severe Weather: Tugs with Tows Less Than 1600 Gross Tons

The winter months from November to February typically bring storm systems to the Bay area that result in high winds and adverse sea conditions. Extreme wind conditions of 50 knots gusting to 75 knots have occurred during the winter, occasionally requiring the San Francisco Bar to be closed to tug and tow traffic.

These best practices are meant to serve as guidelines, and are not meant to relieve the mariner of his or her responsibility to follow applicable rules and regulations addressing prudent seamanship. Furthermore, they are designed to address vessels in the service of routine cargo transport, and are not meant to prohibit tug rescue or salvage operations.

Factors to consider when closing the Bar or limiting transits in the Bay. A number of factors must be considered when limiting transits in the Bay or closing the Bar due to severe weather, including sea state, tidal influences, visibility, traffic density, and wind advisories issued by NOAA. The size and condition of the vessels being addressed must also be considered. The Tug Escort Work Group recommends a tiered approach, applying greater caution as conditions worsen.

Sustained winds exceeding 25 knots in the Bay

- Tugs with tows should closely evaluate whether it is safe to transit in the Bay. Size and sail area of the vessel, tidal influences, visibility, operator skill and traffic density should all be considered.

- VTS San Francisco will establish regular communications with bridge watches of VTS users in Bay Area anchorages, and more closely monitor swing circles to ensure vessels are not dragging.

Sustained winds exceeding 40 knots in the Bay

- Transits to and from berths are not recommended, but may be performed following a careful risk management evaluation by the vessel operator and vessel management.

Sustained winds exceeding 40 knots and/or seas exceed 12 ft at the Sea Buoy

- Bar traffic restrictions and closure should be considered for tugs and tows. Size of the vessel, draft, swell period, tidal influences, visibility, and traffic density should all be considered. Strong ebb tides should be avoided, and a minimum of 10 feet under-keel clearance is recommended.

Fog

Fog is a common occurrence in the Bay Area, particularly around the Golden Gate. It is most frequent during the summer, occasional during fall and winter, and infrequent during spring. Although daily and seasonal fog cycles are predictable, long-term fluctuations are not. Fog patterns can differ within the Bay region on the same day because of the unique geography of the Bay, which consists of two mountain ranges and the large expanse of bays and a major river system. Depending on the location, an area may experience high, dense or relatively little fog. The following is a brief summary of fog conditions in the Bay.

Winter. Winter fogs are usually radiation fog or “tule” fog. With the clear skies and light winds of winter, land temperature drops rapidly at night. In low, damp places such as the Delta and Central Valley (where tules and marsh plants grow), an inversion develops over the inland valleys. Widespread radiation fog will then develop if the surface is sufficiently moist (e.g., after soaking rains). Tule fog is notoriously thick and dense.

In the winter months from late November to early March, fog can develop in the Valley overnight. Visibilities often fall to near zero in the Delta, southern Sacramento Valley, and northern San Joaquin Valley, making marine navigation in these areas difficult. Lowest visibilities occur late during the night through mid-morning hours. Visibilities improve by late morning and often the fog layer lifts into a low overcast during the afternoon.

Sometimes, if there is a light offshore flow during a tule fog event, dense fog can drift westward from the Delta through the Carquinez Strait and into San Francisco Bay. Visibilities can drop below 0.5 mile and stay below 0.5 mile for many hours, and in worst cases, several days. In contrast to the summer fog that moves from sea to land at about 14 knots, the winter tule fogs move slowly seaward at about one knot.

Summer. Summer fog is dependent on several routine conditions. The Pacific High becomes well established off the coast and maintains a constant Northwest wind. It also drives the cold California Current south and causes an upwelling of cold water along the coast. Air closest to the surface becomes chilled so that the temperature increases with altitude. This process forms an inversion layer at 500-1500 feet, where the air is warmer at this level than the air below it. Moist, warm ocean air moving toward the coast is cooled first by the California Current, then more by cold coastal water. Condensation occurs and fog will form to the height of the inversion layer. This happens often enough to form a semi-permanent fog bank off the Golden Gate during the summer.

Under normal summer conditions a daily cycle is evident. A sheet of fog forms off the Golden Gate headlands during the morning and becomes more extensive as the day passes. As the temperature in the inland valleys rises, a local low pressure creates a steady onshore wind. By late afternoon, the fog begins to move through the Golden Gate at a speed of about 14 knots on the afternoon sea breeze. Once inside the Bay it is carried by local winds. In general, the northern part of the Bay is the last to be enveloped and the first to clear in the morning. There are times when the flow is strong enough to carry the sea fog as far east as Sacramento and Stockton. If this continues for a number of days, cooler ocean air replaces the warm valley air and causes the sea breeze mechanism to break down. Winds then diminish and the Bay Area clears for a few days; the valley then slowly reheats and the cycle begins anew.

Safety Considerations in Reduced Visibility

Navigating the San Francisco Bay Region during periods of reduced visibility requires mariners to exercise additional caution and vigilance. The Bay region is one of the foggiest harbors in the United States. In-Bay distances are long. There is not a single regional climate, but a series of microclimates with variable fog. During summer, 30 to 40 percent of parts of the Bay may experience foggy conditions. In winter, the fog is generally denser tule fog.

Dense fog is defined by the National Weather Service as fog that reduces visibility to one-half mile or less on the San Francisco Bay or to one mile or less over the coastal waters. Spring and summer fog is not usually dense over the bays and into the Delta and Central Valley. However, fog can often be dense over the coastal waters when the marine layer is shallow (typically less than 1000 feet deep). During shallow marine layer

scenarios, the coastal mountains act as a barrier blocking fog and low clouds from moving inland. Even with a shallow marine layer, fog can still advect into the Bay through the Golden Gate. In this situation, dense fog is almost always limited to local sections of the San Francisco Bay, primarily from the Golden Gate to Berkeley.

Large Vessels and Tugs with Tows 1600 Gross Tons or greater. The following guidelines should be used by the mariner when planning, initiating or navigating a transit in the Bay during periods of reduced visibility. These guidelines acknowledge that large vessels are not as maneuverable as smaller vessels and therefore define “Large Vessels” as power driven vessels of 1600 gross tons or more, and tugs with tows of 1600 gross tons or more. Mariners are at all times to comply with the requirement of the International Regulations for Avoiding Collisions at Sea, or COLREGS.

Critical Maneuvering Areas (CMAs). There are areas within the Bay where additional standards of care are required due to the restrictive nature of the channel, proximity of hazards, or the prevalence of adverse currents. Large vessels should not transit through CMAs when visibility is less than 0.5 nautical miles.

Locations within the Bay identified as Critical Maneuvering Areas:

Redwood Creek

San Mateo-Hayward Bridge

Oakland Bar Channel*

Islais Creek Channel

Richmond Inner Harbor

Richmond-San Rafael Bridge, East Span

Union Pacific Bridge

New York Slough, up-bound

Rio Vista Lift Bridge

*Note: the Oakland Bar Channel is identified due to cross currents and its proximity to the Bay Bridge and Yerba Buena Island.

Vessels docked: Large vessels at a dock within the Bay should not commence a movement if visibility is less than 0.5 nautical miles at the dock.

Vessels proceeding to dock: Large vessels proceeding to a dock should anchor if visibility at the dock is known to be less than 0.5 nautical miles, unless, under all circumstances, proceeding to the dock is the safest option.

Tugs with Tows less than 1600 Gross Tons. These best practices should be used by the mariner when planning, initiating or navigating a transit in the Bay during periods of reduced visibility. They acknowledge that the size of a tug and tow have much to do with their maneuverability, and therefore, are limited to tugs with tows with a displacement of less than 1600GT. Finally, the best practices are meant to serve as guidelines, and are not meant to relieve the mariner of his or her responsibility to follow applicable rules and regulations addressing prudent seamanship including the requirement of the International Regulations for Avoiding Collisions at Sea, or COLREGS.

Critical Maneuvering Areas (CMAs): The areas within the Bay where additional standards of care are required due to the restrictive nature of the channel, proximity of hazards, or the prevalence of adverse currents, are listed above. Tugs with tows less than 1600GT should not transit through CMAs when visibility is less than 0.25 nautical miles. Tugs with tows in petroleum service should not transit through CMAs when visibility is less than 0.5 nautical miles.

Locations within the Bay identified as Critical Maneuvering Areas:

Redwood Creek

San Mateo-Hayward Bridge

Oakland Bar Channel*

Islais Creek Channel

Richmond Inner Harbor

Richmond-San Rafael Bridge, East Span

Union Pacific Bridge

New York Slough, up-bound

Rio Vista Lift Bridge

*Note: the Oakland Bar Channel is identified due to cross currents and its proximity to the Bay Bridge and Yerba Buena Island.

Vessels docked: Tugs with tows less than 1600GT at a dock within the Bay should not commence a movement if visibility is less than 0.25 nautical miles at the dock. Tugs with tows in petroleum service at a dock within the Bay should not commence a movement if visibility is less than 0.5 nautical miles at the dock.

Vessels proceeding to dock: Tugs with tows less than 1600GT proceeding to a dock should anchor if visibility at the dock is known to be less than 0.25 nautical miles, unless, under all circumstances, proceeding to the dock is the safest option. Tugs with tows in petroleum service proceeding to a dock should anchor if visibility at the dock is known to be less than 0.5 nautical miles, unless, under all circumstances, proceeding to the dock is the safest option.

Vessel pilots or operators should notify VTS upon determination that a scheduled movement will be delayed or cancelled. If underway, they shall make a sailing plan deviation report per VTS regulations. The operator's local knowledge should include an understanding of historic weather patterns during that time of year, current weather reports and checking with reporting stations along the route. This guidance acknowledges that the Bay region is a series of bays and rivers, in-Bay distances are long and there is not a single Bay region climate, but a series of many microclimates with variable fog. The Captain of the Port has the authority to prohibit movement of vessels within all or portions of the Bay during adverse weather conditions.

Because of the large size of the Bay (500 square miles), the longer distances traveled to the various ports, and the diverse weather conditions encountered in the Bay, mariners are dependent on accurate weather forecasting for vessel movements. The National Weather Service broadcasts marine weather information on VHF WX 1,2,3, and 4.

Currents And Tides

Currents

The currents at the entrance to San Francisco Bay are variable and can attain considerable velocity. Immediately outside the Golden Gate bar is a slight current to the North and West known as the Coast Eddy Current. The currents that have the greatest effect on navigation in the Bay and out through the Golden Gate are tidal in nature.

Golden Gate Flood Current. In the Golden Gate the flood or incoming current sets (direction of flow) straight in with a slight tendency to the northern shores and with heavy turbulence at both Lime Point and Fort Point when the flood is strong. This causes an eddy or circular current between Point Lobos and Fort Point.

Golden Gate Ebb Current. The ebb or outgoing current has been known to reach more than 6.5 knots between Lime and Fort Points. It sets from inside the northern part of the Bay toward Fort Point. As with the flood, it causes an eddy between Point Lobos and Fort Point, and a heavy rip and turbulence reach a quarter of a mile south of Point Bonita.

Golden Gate Current Maximums. In the Golden Gate the maximum flood current occurs about an hour-and-a-half before high water, with the maximum ebb occurring about an hour-and-a-half before low water. The average maximums are 3 knots for the flood and 3.5 knots for the ebb.

In-Bay Currents. Inside the Golden Gate the flood sets to the Northeast and causes swirls and eddies. This is most pronounced between the Golden Gate, Angel Island and Alcatraz Island. The current sets through Raccoon Strait (north of Angel Island), taking the most direct path to the upper Bay and the Delta area. The ebb current inside the Golden Gate is felt on the south shore first. The duration of the ebb is somewhat longer than the flood due to the addition of runoff from the Sacramento and San Joaquin Rivers.

Tides

Tides in the San Francisco Bay Area are semi-diurnal in that there are usually two cycles of high and low tides daily, but with inequality of the heights of the two. Occasionally the tidal cycle will become diurnal (only one cycle of tide in a day). As a result, depths in the Bay are based on “mean lower low water” (MLLW), or the average height of the lower of the two daily low tides. The mean range of the tide at the Golden Gate is 4.1 feet, with a diurnal range of 5.8 feet. During the periodic maximum tidal variations the range may reach as much as 9 feet and have lowest low waters 2.4 feet below mean lower low water datum.

Safety Considerations Associated with Current and Tide Conditions. In late 1991, the National Oceanic and Atmospheric Administration (NOAA) stopped publishing the local tidal current charts due to significant errors in predictions that exceeded NOAA standards. Because safe navigation is highly dependent upon accurate tidal and current information, the Physical Oceanographic Real Time System (P.O.R.T.S.) was installed to give near-real time tide and current data updated every six minutes. P.O.R.T.S. is managed by the Marine Exchange of the San Francisco Bay Region (SFMX) with technical assistance from NOAA/NOS. Consistent funding is still to be identified for long term operation of the system in the Bay.

P.O.R.T.S continues to be of great benefit to recreational boaters, commercial shippers, vessel masters and pilots in providing accurate knowledge of winds, currents and other environmental parameters used by the San Francisco maritime community.

Data from the sensors is collected and subject to automatic preliminary quality control at the Data Acquisition System (DAS) located at the SFMX. The data is quality-tested in much greater detail on a 24-hour/7-day per week basis under a program called the Continuous Operating Real Time Monitoring System or CORMS. CORMS employs knowledgeable oceanographers at NOAA’s National Ocean Service headquarters in Silver Spring, Maryland, who monitor the data quality and sensor performance using data quality control tests and remote sensor and DAS diagnostics.

Management of P.O.R.T.S., including administration, field maintenance and repair and the DAS, was handed over to the SFMX, located at Lower Fort Mason Center in San Francisco. The P.O.R.T.S. Advisory Workgroup is studying various funding options in order to continue operating the system, and has made a recommendation to request general State funding.

Access to P.O.R.T.S. information may be obtained by logging onto the SFMX website at www.sfm.org or by contacting the automated voice response number: (866) 727-6787.

Marine Weather Services

The National Weather Service (NWS), a part of the National Oceanic and Atmospheric Administration (NOAA), provides marine weather warnings and forecasts to serve all mariners who use the waters for livelihood or recreation. The warning and forecast program is the core of the NWS's responsibility to mariners. Warnings and forecasts help the mariner plan and make decisions protecting life and property. The NWS also provides information through weather statements and outlooks that supplement basic warnings and forecasts. The following are the basic marine warning products the NWS offers:

Small Craft Advisory: Forecast winds of 22 to 33 knots and/or hazardous sea conditions (usually seas greater than 10 feet).

Gale Warning: Forecast winds of 34 to 47 knots.

Storm Warning: Forecast winds of 48 knots or higher.

Dense Fog Advisory: Visibility reduced to one-half mile or less in the bay. Visibility reduced to one mile or less in the coastal waters.

Special Marine Warning: Potentially hazardous over-water events of short duration (two hours or less) such as thunderstorms with strong gusty winds.

Advisories and warnings listed above are headlined in the Coastal Waters Forecast (CWF). In addition to headlining hazardous weather conditions, the CWF includes forecast information on wind speed and direction, waves, swell, and significant weather (including fog, rain or showers, and thunderstorms). Beginning in March 2006, NWS San Francisco Bay Area began issuing a specific forecast for the San Francisco Bar as part of the Coastal Waters Forecast (CWF) product. The bar forecast includes expected sea state conditions for the next two periods (e.g., tonight and tomorrow), times of maximum ebb current through the Golden Gate and across the bar, and expected hazards such as a small craft advisory for hazardous bar conditions and/or breaking waves on the bar. The bar forecast is updated four times a day along with the rest of the CWF.

Marine Warning and Forecast Dissemination

Marine weather observations, forecasts, and warnings are disseminated through a wide variety of methods, including those listed below.

NOAA Weather Radio (NWR): The NWR network provides voice broadcasts of coastal marine forecasts on a continuous cycle. Broadcast coverage extends across the bays and typically offshore about 25 nautical miles. When severe weather threatens, an alarm tone is sent to automatically turn on compatible NWR receivers in the transmitter's coverage area. Transmitters that broadcast in the San Francisco Bay Area include:

Frequency	Call Sign	Location
162.400 MHz	KHB-49	San Francisco (Mt. Pise)
162.500	KDX-54	San Francisco North Bay Marine (Big Rock Ridge)
162.550	KEC-49	San Jose/Monterey (Mt. Umunhum)
162.450	WWF-64	San Jose/Monterey Marine (Mt. Umunhum)
162.425	KZZ-75	East Bay/Delta (Mt. Diablo)

The Internet

- National Weather Service San Francisco Bay Area: weather.gov/sanfrancisco
- NWS San Francisco Bay Area marine forecast web page:
www.wrh.noaa.gov/mtr/marine.php
- Point and Click Marine Forecast: The NWS now offers the opportunity to get a site-specific forecast instead of relying on a zone forecast:
www.wrh.noaa.gov/firewx/fwpfm/fwpfm.php?wfo=mtr&interface=marine
By selecting any spot on the interactive map, the web page user will receive a forecast table that will include specific information on winds, waves, swells and other parameters for the next seven days.
- Buoy and Coastal Observation Information: Wind and wave data from offshore buoys, as well as other coastal weather observations, can be found at:
www.wrh.noaa.gov/mtr/buoy.php

Buoys data can also be obtained over the phone using the National Data Buoy Center's "dial-a-buoy" service: 1-888-701-8992.

Use the buoy number below when prompted to access the latest buoy observations.

Buoy #	Lat/Long	Location
46013	38.2N/123.3W	Bodega Bay
46026	37.8N/122.8W	San Francisco
46012	37.4N/122.9W	Half Moon Bay
46042	36.8N/122.4W	Monterey

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