SECTION I

HURRICANE TERMINOLOGY AND INFORMATION FOR MARINA MANAGERS

A. Hurricane Terminology

Tropical Disturbance: A moving area of concentrated showers in the tropics, which maintains its identity for 24 hours or more.

Tropical Depression: An area of disturbed weather associated with low pressure and wind circulation at the surface. Highest sustained winds are less than 39 mph.

Tropical Storm: Same as above except highest sustained winds range from 39 to 73 mph.

Hurricane: Same as above except highest sustained winds are 74 mph or higher.

Advisory: A message released by a Hurricane Center, usually at six-hour intervals, updating information on the storm or hurricane including watches and warning whenever they are in effect.

Special Advisory: Same as Advisory but is issued whenever there is a significant change in any information previously released.

Intermediate Advisory: Updates information contained in Advisories at 2 to 3 hour intervals whenever a watch or warning is in effect.

Gale Warning: Wind speed of 39 – 54 mph expected.

Storm Warning: Wind speed of 55 – 73 mph expected.

Hurricane Season: June 1st through November 30th.

Hurricane Watch: A hurricane may threaten your area.

Hurricane Warning: A hurricane is expected to strike your area within 24 hours or less.

Tornado Watch: Tornadoes and severe thunderstorms are possible in your area.

Tornado Warning: Tornado detected in your area, TAKE SHELTER.

Storm Surge: A rise in water level above normal levels due to wind stress or, in the case of a hurricane, wind stress plus very low atmospheric pressure. Storm surge can raise water levels 17 to 20 feet causing extreme flooding. The impact worsens because the deeper water levels caused by storm surge allow larger waves to approach and break on otherwise protected structures.

B. Hurricane Categories

Category 1: Winds 74 to 95 MPH - 4 to 5 foot storm surge. Damage primarily to shrubbery, trees, and unanchored mobile homes. No real damage to other structures. Some damage to poorly constructed signs. Low-lying coastal roads inundated, minor pier damage, some small craft in exposed anchorage torn from moorings.

Category 2: Winds 96 to 110 MPH - 6 to 8 foot storm surge. Considerable damage to shrubbery and tree foliage; some trees blown down. Major damage to exposed mobile homes. Extensive damage to poorly constructed signs; some damage to roofing materials on buildings and some window and door damage. No major damage to buildings. Coastal roads and low-lying escape routes inland cut by rising water two-four hours before arrival of the hurricane's center. Considerable damage to piers. Marinas will flood and small craft in unprotected anchorages may be torn from moorings.

Category 3: Winds 111 to 130 MPH - 9 to 12 foot storm surge. Foliage torn from trees and large trees blown down. Practically all poorly-constructed signs blown down; some damage to roofing materials of buildings; some window and door damage; and some structural damage to small buildings. Mobile homes destroyed. Serious flooding at coast and many smaller structures near coast destroyed; low-lying escape routes inland cut by rising water three-five hours before the hurricane's center arrives.

Category 4: Winds 131 to 155 MPH - 13 to 18 foot storm surge. Shrubs and trees blown down; all signs down. Extensive damage to roofing materials, windows and doors; complete failure of roofs on many small residences; complete destruction of mobile homes. Major damage to lower floors of structures near shore due to flooding and battering by waves and floating debris.

Category 5: Winds 156 MPH and above - 18 foot and above storm surge. Shrubs and trees blown down; considerable damage to roofs of buildings; all signs down; very severe and extensive damage to windows and doors; complete failure of roofs on many residences and industrial buildings; extensive shattering of glass in windows and doors; some complete building failures; small buildings overturned or blown away and complete destruction of mobile homes. Low-lying escape routes inland cut by rising water three-five hours before the hurricane's center arrives.

C. Saffir-Simpson Hurricane Scale

Storm Category	Barometric Pressure (Inches)	Winds (MPH)	Storm Surge (Feet)
1	28.94	74 – 95	4 – 5
2	28.50 – 28.91	96 – 110	6 – 8
3	27.91 – 28.47	111 – 130	9 – 12
4	27.17 – 27.88	131 – 155	13 – 18
5	27.17	155	18+

D. Knowing What To Expect [1]

Preparing a marina and boats for a hurricane means defending against wind, rain, waves, and high water; all in proportions rarely experienced. Damage is usually due to a combination of factors.

SURGE

The damaging influence of high water, or storm surge, is often underestimated in preparing a marina or a boat for a storm. Storm surge raises the water level far above normal high tide, cutting off roads, forcing evacuation, and lifting boats above their docks and pilings. Surge accounts for major damage because it puts docks underwater as the boat tries to float above.

Surge is the result of several factors. Due to low barometric pressure, the ocean surface is drawn upward forming a mound about one foot higher than the surrounding ocean. Large swells generated by the storm reach land first, while storm winds drive water towards the coast. As the storm makes landfall, water levels 10 to 20 feet above normal high tide are possible. Determining storm surge values is highly dependent on the slope of the continental shelf in the landfall region. The values for storm surge in the Saffir-Simpson Hurricane Scale are estimates only. The actual storm surge value (in feet) is also dependent on the storm’s forward speed, tide level and degree of dredging activities on the coastline. Storm surge is typically greater on a coastline when a storm’s forward speed is fast; however, for inlets, sounds and bays, the surge can be greater during slower moving storms because the wind will have more time to pump water into these areas. Surge is responsible for extensive flooding and much of the loss of life that accompany a hurricane. Dangerous high tides can reach outward 20 to 50 miles from the storm's center. Surge makes extra length and positioning of dock and mooring lines critical.

WIND

A hurricane, of course, brings high winds. Wind speeds of 70 to 130 mph are common, and winds of over 200 mph have been recorded. What may be less understood is the force created by such winds. When wind speed doubles, the wind pressure quadruples. When the wind speed increases, the damage it causes increases at a much greater rate. This illustrates the importance of reducing a boat's windage by removing as much rigging, canvas, and deck gear as possible, and facing the bow toward the greatest exposure.

WAVES

Waves in the ocean have tremendous energy and can reach mountainous heights. But even in relatively small harbors, sounds, and lakes, waves can build to surprising heights. In a hurricane, it is not unusual for steep, breaking waves three to six feet high to pound normally peaceful harbors. Sea walls, barrier beaches, and other structures that normally protect docks and moorings are submerged by the storm surge. This has the effect of greatly extending the "fetch," or distance, over which the wind can generate waves.

RAINFALL

Rainfall of 6" to 12" within 24 hours is normal during a hurricane with extremes of 24" having been recorded. Typically, the slower the forward speed of the storm, the more rainfall. A rough method to estimate rainfall in inches is to divide the forward speed of the storm into 100. A hurricane that struck Puerto Rico in 1928 is estimated to have dumped over two and a half billion tons of water on the island. Boats that are spared the worst high water and wind still can be sunk by the torrential rain. Cockpit decks are seldom 100% water tight; and the ability of a bilge pump and battery to handle rain accumulation is greatly overestimated. Deck drains and pump discharges located near the waterline can backflow when waves and rain put drains under water.

TORNADOES

Tornadoes are sometimes spawned by hurricanes. Of the 46 people who died during Hurricane Carla in 1961, 11 were killed by tornadoes. Little can be done to protect a boat from a tornado. The possibility of a "twister," however, is a strong reason for you, your family, and your boat, if it is trailerable, to be far from the coast when a hurricane makes landfall.

E. Estimating Storm Force at your Location

Your marina location relative to the path of the hurricane will determine the force and damage you may expect. Plot the storm path from National Weather Service Reports. Hurricane winds run counter-clockwise, and the greatest wind speed, tidal surge, and heaviest rainfall will be to the right of the storm's eye when looking in the direction of its path. Depending on the storm's intensity, the maximum tidal surge will be 15 to 20 miles to the right of the eye.

The left quadrant of the storm as you look in the direction of its path has less force than the right side, but is still dangerous. Should the storm pass directly overhead, you will experience winds reducing to minor gusts within the eye until the "back side" of the hurricane arrives. When this happens, the winds will reverse direction and will be at or near the intensity experienced on the front side of the storm. It may take as long as 30 minutes for the eye to pass. Remember to anticipate a change in wave direction and reduced water depth when the backside of the storm arrives.

(1) Source: BOAT/U.S. Marine Insurance Damage Avoidance Program

Recreational fishing boats at Lewes Marina - Lewes, Delaware.