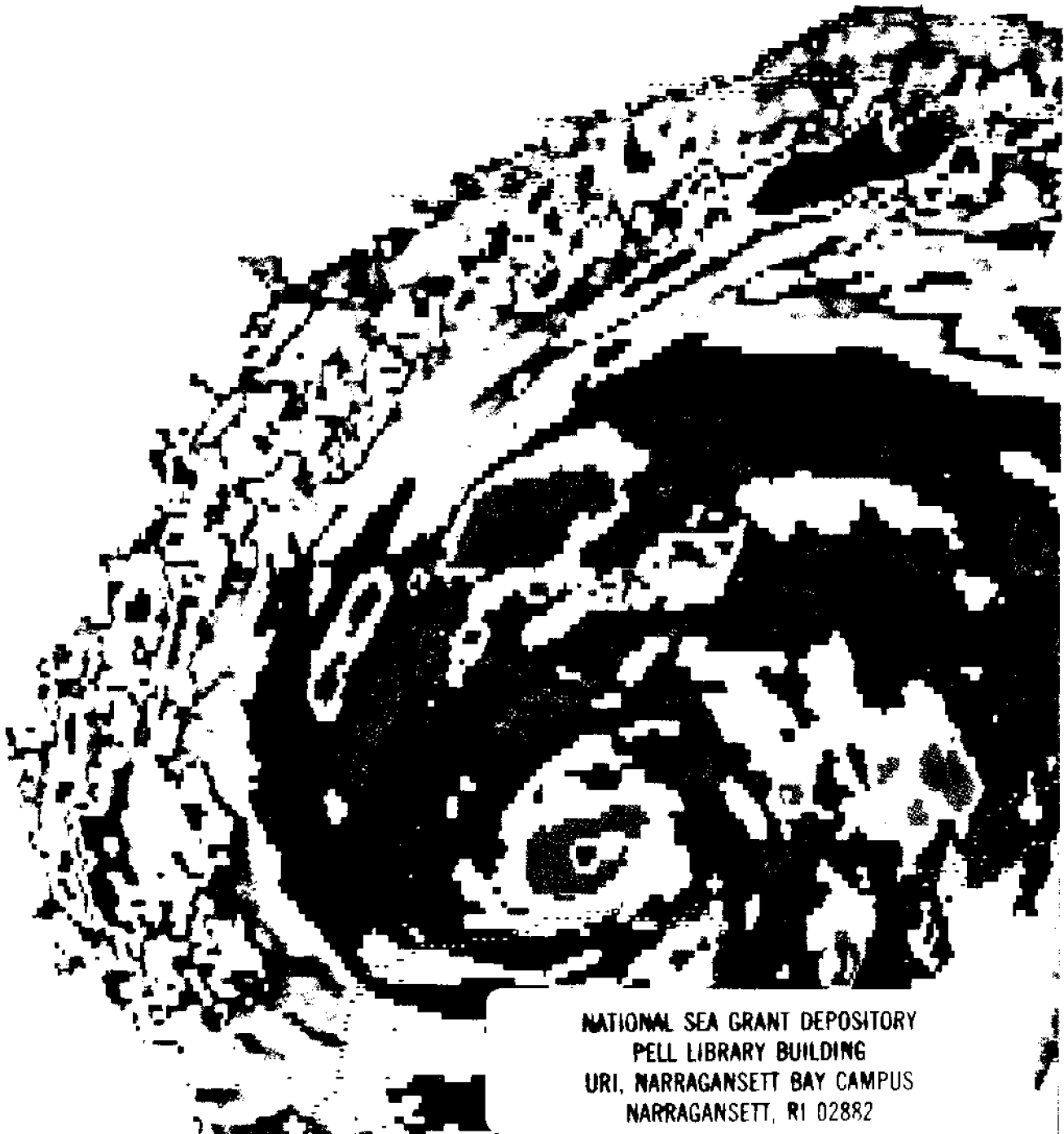


# TEXAS COAST HURRICANES

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TEXAS A&M UNIVERSITY  
SEA GRANT COLLEGE PROGRAM

## **TEXAS SEA GRANT COLLEGE PROGRAM**

The Texas A&M University Sea Grant College Program is a partnership of university, government and industry, focusing on marine research, education and advisory service. Nationally, Sea Grant began in 1966 with the passage of the Sea Grant Program and College Act. Patterned after the Land Grant Act of the 1860s, the Sea Grant concept is a practical, broad-based scientific effort to better the world for all those living in and out of the sea.

### **ADMINISTRATION**

Texas A&M University's \$3.5 million Sea Grant College Program is directed by a team of able administrators. Dr. Thomas Bright, a professor of oceanography, serves as director of the overall management team with an emphasis in the guiding research activities. Additional members of the program management staff are Dr. Lauriston King, deputy director; Willis (Bill) Clark, associate director; J. Allen Martin, fiscal officer/assistant to the director; Donn Ward, Marine Advisory Service Program Coordinator; Amy Broussard, head of the Marine Information Service and Robert James, Marine Education Program Coordinator.

### **MARINE RESEARCH**

From laying the seeds for a new shrimp farming industry in Texas to tracking response to killer hurricanes roaring out of the Gulf of Mexico, Texas Sea Grant strives to increase knowledge across a broad spectrum of marine-related fields. Indeed, research is the largest of Texas Sea Grant's components, accounting for approximately 40 percent of the annual budget. The research program areas include fisheries, engineering, mariculture and coastal environment. Research grants, which are awarded on a competitive and peer-review basis, are the foundation for the future of our coast.

### **MARINE ADVISORY SERVICE**

Administered by the Texas Agricultural Extension Service and supported by Texas Sea Grant and the county commissioners' courts in nine coastal communities, the Marine Advisory Service is a centerpiece in an effort to get information to user groups here in the state. Against this background, marine research that ripples through the academic community is transmitted to the general public. Whether it's through workshops, publications or just one-on-one down on the docks, the goal is to help people deal more effectively with the marine environment without harming it.

### **MARINE EDUCATION**

The philosophy behind the Sea Grant marine education program at Texas A&M is to develop awareness and understanding of the ocean's place in our environment and its influence on our lives, and to foster wise use of the ocean and its inhabitants today and in the future. There are no age or subject boundaries. Marine education is available for all students—pre-school through adult—and at all levels of learning—from highly technical scientific studies to sea-related music and literature to safety practices.

### **TEXAS A&M UNIVERSITY**

In 1968 Texas A&M University received the distinction of being named among the nation's first six institutional award recipients. Three years later the school was designated a Sea Grant College. The university has a rich heritage of oceanography research dating back to 1949 when the program began. In addition there is an on-going program to get marine information to the public. Sea Grant is a matching funds program. The Texas A&M Sea Grant College Program itself is made possible through an institutional award from the National Oceanic and Atmospheric Administration, U.S. Department of Commerce, and appropriations from the Texas Legislature and local governments.

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Design by Norman Martin. Editors: Amy Broussard and Norman Martin.

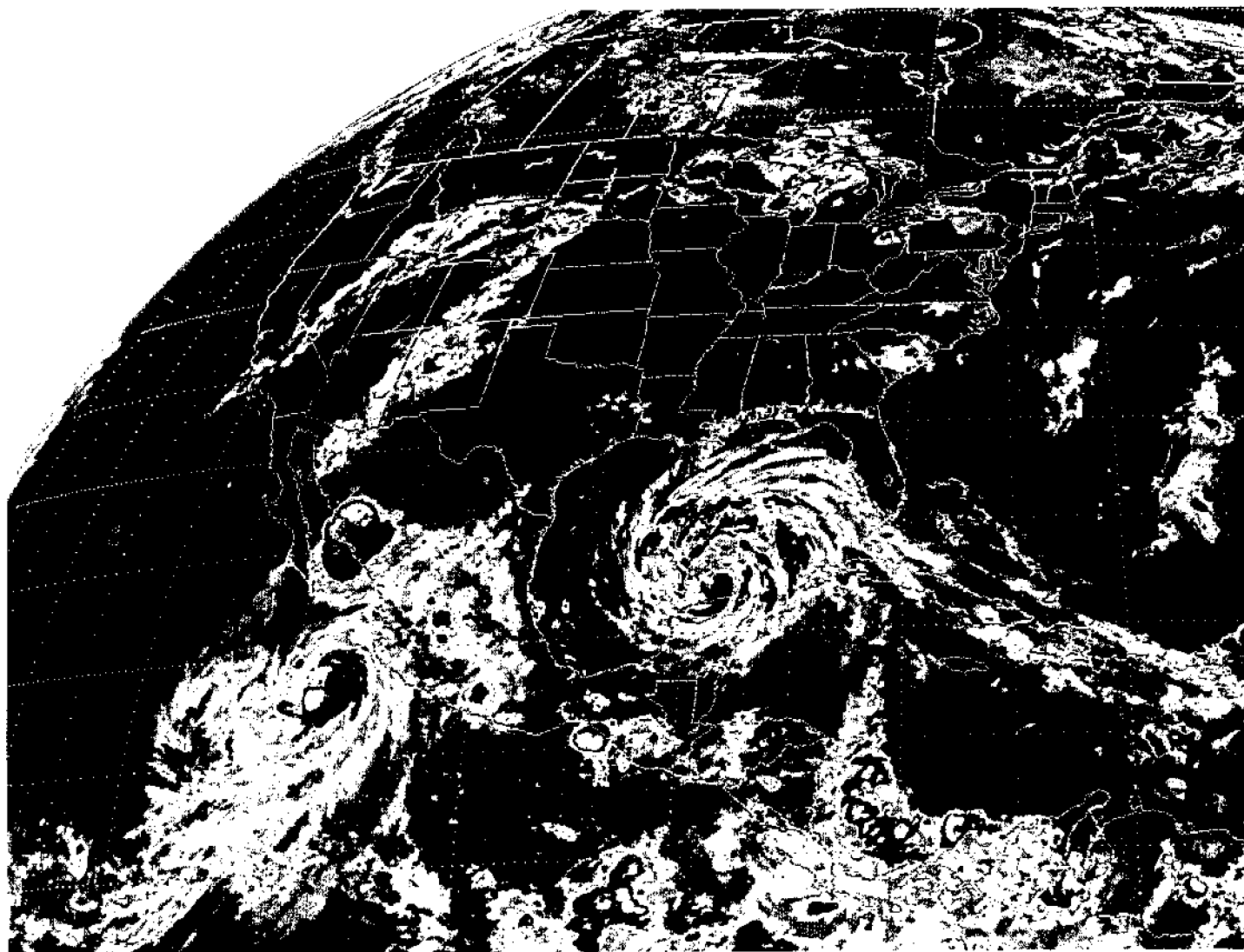
# FOR THE RECORD

**C**arla. Beulah. Allen. Alicia. They may not sound like killers, but they are. They are hurricanes that have caused death and costly destruction along the Texas coast. For newcomers to Texas, however, these names and the memory of their devastation can have little meaning. Indeed, the risks to life and property from these storms have probably increased because many new settlers in coastal counties have had no personal experience with the energy locked up in these storms—or with their offspring, floods, lightning storms and tornadoes.

This publication is designed to reduce the risks from severe coastal storms and hurricanes by describing what they are, how they work, the reasons why they can be so destructive, and the steps that individuals can take to protect themselves, their families and their property. It includes step-by-step instructions (in both English and Spanish) for hurricane preparation and evacuation plans, tracking charts, suggestions for recovery after a storm, and lists of additional publications on hurricanes and hurricane awareness.

TEXAS COAST HURRICANES is based on current scientific knowledge developed by Texas A&M University and government researchers. Its widespread distribution has been assisted by contributions from Celanese Engineering Resins, Inc., Mobil Chemical Company, Exxon Pipeline Company, Entex Corporation, and Soltex Polymer Corporation.

# THE HURRICANE



**O**n Sept. 7, 1900, Galveston was a place of calm beauty. But a day later, packed in a screaming swirl of wind and rain, the fury of a full-blown hurricane settled on this historic Texas town. Beach water levels soared more than 20 feet above normal.

Six thousand people were killed. It was the worst natural disaster in U.S. history.

Unfortunately, even in these high-tech times a similar catastrophe could happen again on the Gulf coast. Two statistics about the coastal population illustrate the problem. Development along the beach front is increasing at a rate three times faster than in the rest of the United States. And, 80 percent of the people who live along the Atlantic and Gulf coasts have never experienced a major hurricane.

Moreover, there are millions of people who visit the beach during hurricane season — June 1 to November 30. Evacuation of vulnerable areas takes 20 hours or more in

many places. For instance, the best estimates for Galveston are 25 to 30 hours. No one can provide that much lead time.

Only people who have lived through the worst of a major hurricane know its true power. For many Texans it's easy to develop feelings of over confidence since most have only gone through the fringes of a major hurricane. "We're more vulnerable to the hurricane than we have ever been in our history, and it's primarily a people problem," says Neil Frank, director of the National Hurricane Center in Coral Gables, Fla. "It's because we are locating thousands and tens of thousands of people on islands that historically have gone under water."

## Unequaled In Nature

Hurricanes aren't the biggest storms on earth or the most violent. But their combination of size and violence is unequaled in nature. One day's energy production in a hurricane — if it could be converted to

electricity — could power the entire country for six months.

The giant storms form only over the warm tropical oceans, near but not at the equator. Several form in the Atlantic each year and either curve away from the coastline, hit the United States or continue into Central America. Even more form in the Eastern Pacific because huge stretches of warm Pacific water allow numerous storms to form. A few of these strike the Mexican coast, but most move away from shore.

Hurricanes striking the United States are often triggered by disturbances that form over Africa. About 100 disturbances move across the Atlantic each year between June and November. Yet an average of only six develop into full hurricanes.

## Complex Process

Just how does a hurricane form? Weather experts say the exact process is very complex and not fully understood. But, basically,

the pressure at the center of a developing hurricane falls as the lower layer of air in the core first becomes unusually warm and moist as it absorbs heat and water from the underlying ocean.

Buoyancy of the warm, humid air causes rising currents in the core. The surrounding air then begins to move toward the storm center to replace the rising air and in its turn to be heated and moistened. The earth's rotation causes the inward moving air to spiral around the low, counterclockwise in the northern hemisphere.

"Apparently, it takes a special combination of a number of different events for the tropical storm or the hurricane to form," Frank says. That precise recipe of winds, clouds, and temperatures is only reached occasionally.

Once the hurricane develops, the most unique and easy-to-identify feature of a hurricane is the eye. It's an area of almost no rain, light winds and few clouds—all features resulting from sinking air. It usually ranges from 5 to 30 miles across. The lowest surface air pressures are found here. Surrounding the eye is the eye wall, a towering cylinder of clouds eight to 10 miles high. The air is rising rapidly and the heaviest rain and strongest winds are found here. Much of a hurricane's energy is concentrated in the eye wall.

Away from the center of the hurricane is a spiral of clouds. Under the clouds, spiral bands of heavy rain and strong wind gusts can cause short blasts stormy weather hundreds of miles from the eye. The entire area effected directly by a hurricane is often several hundred miles across, with the area of maximum destruction about 50 miles wide.

Satellite pictures have shown that, though there are many similarities, no two hurricanes are alike. Some are much bigger than others, some produce more rain, some have bigger eyes, and some have their spiral bands concentrated on one side. Few hurricanes are symmetric.

#### Scale Of Power

There are differences in intensity, too. Hurricanes are measured on the Saffir Simpson Scale, which ranges from "1" to "5." A "1" is a minimal hurricane with highest winds barely 74 mph. A "5" has winds of more than 155 mph.

But even the wind of a category "5" hurricane is not the most dangerous aspect of the storm. The biggest threat is water. It's difficult to believe that something as calm as the Gulf can turn into a killer, but water is extremely heavy. A cubic yard weighs almost a ton. Imagine winds pushing that ton of water along at a rapid rate. Multiple that by the millions of cubic yards of water and you have awesome power — power packed

in what weather experts call the storm surge.

"Nine out of 10 people who die in a hurricane drown in the storm surge," Frank says. "Now this is a dome of saltwater maybe 50 miles wide that sweeps across the coastline, near the point where the center of the eye makes landfall.

"On top of that dome you have wind-waves; 5- and 10-foot waves come crashing into shore." Basically, the storm surge is a mound of water partly created by the low pressure in the eye of a hurricane. The final water level, though, varies according to three main factors.

Tides, which are a factor of the gravitational effect of the moon, earth and sun, play a role. Some places have huge differences in height between high and low tide.

The shape of the ocean bottom is another factor. Deep water near the coast means a smaller surge, perhaps 4 feet instead of 10 feet. Shallow water would cause a much higher surge, perhaps up to 16 feet. The third factor is the shape of the coastline.

The surges of the 1900 Galveston hurricane put the island completely under water. Sea walls and strongly constructed buildings offer some protection, but they are not indestructible. The only sure way to avoid damage from a storm surge is not to build in low-lying coastal areas. Since most of the Texas coastal lands are below 20-foot Mean Sea Level, much of the coastal area is susceptible to storm surge damage.

#### Wind And Rain

After the storm surge, wind is the second most dangerous aspect of the hurricane. Buildings that might survive 100 mph winds can be blown away at 200 mph. Each doubling of the wind speed increases the force of destruction four times, so the destructive force of a 200 mph wind is 100 times greater than the force of 20 mph wind.

Another hurricane danger is tornadoes. The twisters tend to form just ahead of hurricane landfall, but are weaker and don't last as long as midwestern tornadoes. Hurricane Beulah in 1967, with 115 tornadoes — 67 in one day — set a national record.

Once a hurricane makes landfall, its energy source is gone. The warm water feeding the giant isn't there anymore and the storm loses its structure. However, the total rainfall doesn't drop. It often rises. Hurricanes sometimes produce large amounts of rainfall, and the resulting flooding causes widespread damage far from the coast. In addition, rainfall will vary tremendously from one hurricane to another. There is no close correlation between rainfall rate and wind speed.

Some weak storms have produced the heaviest rains. For example, tropical storm Claudette in July 1979 dropped 3.5 feet of

## HURRICANE NAMES

**H**urricanes and tropical storms of the Atlantic, Caribbean and Gulf of Mexico have been identified by personal names since 1953, with names revised every six years by the World Meteorological Organization. The names have an international flavor, since hurricanes are tracked by the public and by weather services of other countries as well as the United States. When a disturbance intensifies into tropical storm status, the National Hurricane Center gives it a name from the current list. The following names will be used for hurricanes and tropical storms in the Atlantic, Caribbean and Gulf of Mexico from 1986 through 1991. In the event of an extremely damaging hurricane, that name is retired permanently and a new name is substituted.

1986	1987	1988
Andrew	Arlene	Alberto
Bonnie	Bret	Beryl
Charley	Cindy	Chris
Danielle	Dennis	Debby
Earl	Emily	Ernesto
Frances	Floyd	Florence
Georges	Gert	Gilbert
Hermine	Harvey	Helene
Ivan	Irene	Isaac
Jeanne	Jose	Joan
Karl	Katrina	Keith
Lisa	Lenry	Leslie
Mitch	Maria	Michael
Nicole	Nate	Nadine
Otto	Opheelia	Oscar
Paula	Philippe	Patty
Richard	Rita	Rafael
Shary	Stan	Sandy
Tomas	Tammy	Tony
Virginie	Vince	Valerie
Walter	Wilma	William
1989	1990	1991
Allison	Arthur	Ana
Barry	Bertha	Bob
Chantal	Cesar	Claudette
Dean	Diana	Danny
Erin	Edouard	Elena
Felix	Fran	Fabian
Gabrielle	Gustave	Gloria
Hugo	Hortense	Henri
Iris	Isidore	Isabel
Jerry	Josephine	Juan
Karen	Klaus	Kate
Luis	Lili	Larry
Marilyn	Marcos	Mindy
Noel	Nana	Nicholas
Opal	Omar	Odette
Pablo	Paloma	Peter
Roxanne	Rene	Rose
Sebastien	Sally	Sam
Tanya	Teddy	Teresa
Van	Vicky	Victor
Wendy	Wilfred	Wanda

rain in 24 hours on Alvin, Tex., a small community southwest of Houston. In contrast, some hurricanes produce almost no rain.

It's hard to measure hurricane rain because it blows sideways and often misses rain gauges. Even so, rains up to 30 inches have been measured, resulting in disastrous flooding. Agnes was a minimal hurricane when it hit Florida in 1972. It then weakened even more, but stalled over Pennsylvania and New York, dumping some 20 inches of rain. The resulting floods caused 122 deaths and billions of dollars in damage.

### Shoreline Erosion

Another hurricane-related problem occurs when a hurricane hits a coastline. Erosion at the beach sometimes moves the shoreline several hundred feet. When a hurricane crosses offshore barrier islands, the powerful currents can cut channels completely through an island. Hurricane Allen cut through South Padre Island in 69 places.

In 1983 Alicia eroded more than 100 feet of shoreline on Galveston Island in a single day, says Dr. Bob Benton, a Texas A&M University civil engineer. On the island, and in fact on much of the Gulf coast, shoreline erosion occurs primarily because of hurricanes and tropical storms, he says. The Texas coast has been mapped showing erosion zones and washover channels. The information is public, but many existing home and condominium owners frequently are not aware of these natural hazards.

Meanwhile, there are many problems in trying to evacuate highly populated coastal areas. Often there are few evacuation routes, some with only two traffic lanes. Many of these routes are only a few feet above sea level. This means they can be flooded by rising waters hours before landfall. And with high winds, heavy rain and a hasty evacuation, accidents are inevitable, slowing the process even more.

### Hurricane Watch

The National Hurricane Center in Miami is responsible for tracking and forecasting Atlantic hurricanes. They have three main tools for tracking the storm.

Satellites take pictures every 30 minutes, showing how the storm is moving, in addition to helping provide estimates on how strong it is, and on how much rain it might produce. As a hurricane gets closer to land, reconnaissance aircraft are sent to fly through the storm. These "hurricane hunters" take vital measurements of wind, pressure, temperature and humidity at different levels inside the storm. Finally, when a hurricane is within 200 miles of the coast, radar goes to work. Radar now gives continuous monitoring of the hurricane.



Robert Minovil

When hurricane center officials feel that a certain area is threatened, a "hurricane watch" is issued. It's usually for a very large area, alerting the public, news media and local officials of the potential threat. When the threat becomes imminent, a "hurricane warning" is issued for a smaller section of the coast.

Officials try to issue warnings at least 24 hours before landfall, but some come with 12 hours or less lead time. When the warn-

ing does come, it implies an urgent need for action.

Advanced computer models have helped to improve hurricane forecasting and warning slightly since the 1960's, but slow improvement is expected for the remainder of the century. Because of forecast uncertainty, the large amount of warning time needed and the relatively small area getting the full force of a hurricane, many more people are going to be evacuated than appears necessary

after the storm.

"There's a myth going around the land today that says, 'With all those beautiful satellites up there you must really be doing a great job,'" says Frank. "No, we do a great job observing, there's no question about it. But the satellites do not make forecasts for us, they only tell us what's going on right now."

"Hurricane forecasts are not as accurate as we would like," agrees Dr. Aylmer Thompson, a long-time hurricane observer and professor of meteorology at Texas A&M University. At present, a 24-hour position forecast has an average error of about 100 miles or more. The 48-hour average error is more than twice that. —

"The error results in part from our inability to observe hurricanes adequately," he says. "There are few data-gathering locations over the oceans, and the cost of obtaining them is prohibitive."

Even so, information received from meteorological satellites has greatly aided locating new hurricanes and tracking existing storms. Still, Thompson says it is not the only kind of data required for preparing forecasts.

For instance, consider a hurricane 350 miles off a populated coast. Imagine it is moving toward the coast at 15 mph. This is slightly more than the average speed of such storms. If a hurricane specialist makes an error in the direction forecast of only 10°, the storm will strike the coast about 75 miles away from the forecasted landfall. That is about the distance between Miami and West Palm Beach in Florida, or between Galveston and Port Arthur in Texas.

#### Must Overwarn

"It is easy to see why hurricane forecasters tend to, indeed must, overwarn," Thompson says. Most local, county and state officials in hurricane-prone areas have already prepared detailed hurricane emergency procedures. And local newspapers, as

well as radio and television stations, regularly have articles or programs related to damage and injury reduction near the beginning of hurricane season.

"The surest approach is to take damage reduction precautions such as boarding up windows and removing loose objects as early as possible before a storm is expected to arrive," Thompson says. "Then evacuate if recommended by local officials."

Ultimately, he says, "The best precaution is to know in advance what these storms are and what they are capable of doing. Then plan in advance what you would do to protect yourself, your family and your property."

A hurricane is truly different from all other storms. It even has its own name. Thompson says that tropical storms are given names when they reach a sustained wind speed of at least 39 mph. "It's much easier to refer to a name and year for a storm than to use any other reference procedure suggested so far," he says.

#### What's In A Name

A list of names is selected several years in advance by the World Meteorological Organization. Since 1979 the list has alternated between men's and women's names. Several different lists are prepared. No name reappears more than once each six years.

Names can be dropped, though. When a storm is especially significant, such as Allen of 1980, that name is permanently retired and removed from the name lists. "Claudette" of 1979 reappears on the list for 1987, but "David" and "Frederic" of the same year have been retired. Hurricane David, Aug. 25 to Sept. 7, 1979, caused \$320 million damage in the United States alone, and accounted for 12 deaths in this country and 56 in Dominica.

As David was weakening, hurricane Frederic was moving slowly through the Caribbean, finally making landfall at Dauphin Island, Ala., on Sept. 13, 1979. Five deaths

were directly attributed to Frederic in the United States. The damage estimate of \$2.3 billion makes Frederic the costliest hurricane ever to hit the nation.

Hurricanes come in many types, but in simple terms they are giant whirlwinds of air moving in a large, tightening spiral around a center of low pressure. A hurricane consists of four parts, three rings all centered around a relatively calm inner core called the eye.

Technically, a hurricane is a revolving mass of air some 10 miles deep and as much as 1,000 miles across. In order to be officially called a hurricane, the strongest winds in the storm must be at least 74 mph. Anything weaker is known as a tropical storm or tropical cyclone. All are classed as tropical cyclones.

Hurricanes develop in most, but not all, subtropical and tropical ocean areas. These include the Atlantic Ocean, between about 10°N and 30°N, the Caribbean Sea and the Gulf of Mexico. The storms tend to move first westward, then northward, and finally northeastward if they live long enough.

#### Erratic Movements

"In a word, their movements can be erratic," Thompson says. "Sometimes they even move in loops. 'They can be motionless or they can move at speeds exceeding 40 mph,'" he says. The average forward speed is near 10 mph.

Thompson explains that the storms develop over very warm sea waters and tend to dissipate, sometimes rather slowly, once they move away from the warmer waters or move over land. Most form in July through October, he says, although they sometimes develop both earlier and later.

Typically, a 50-mile-long stretch of coastline in one of these sea areas can expect a moderate or strong hurricane on the average of once every five years. Occasionally, though, this hypothetical stretch of coastline has been known to suffer from two hurricanes in the same year. Hurricanes have

Here is a table giving the total by month of hurricanes or tropical storms that crossed the Texas coast, moved into Texas from Mexico or Louisiana, or affected the Texas coast as they passed through the Gulf of Mexico. The period covered 115 years between 1871 and 1985. The number may be interpreted as the approximate percent probability that some part of Texas would be affected by a tropical cyclone in a given month. Texas has about a 43 percent (50 out of 115 years) of not being affected by a hurricane or tropical storm during any given year. Note that no tropical cyclone has affected Texas during the months of December through May, at least since 1871.

#### HURRICANE CHANCES

	June	July	August	Sept.	Oct.	Nov.
Hurricane	7	6	15	13	3	
Tropical Storm	7	6	4	11	2	1
Hurricane came close	2	0	5	8	1	
Tropical Storm came close	2	1	5	5	0	

Number of years without a tropical storm or hurricane: 50

been observed along all coasts of North and Central America south of about 60°N on the eastern coasts and south of about 38°N on the Pacific coasts.

Basically, Thompson says, hurricanes begin in small areas of thunderstorms or small tropical cyclones embedded in the westward-blowing trade winds of the tropics. Drawing their energy from heat released during condensation of the water vapor in the warm near-surface air of the tropical regions, these disturbances can increase in dimension, speed and intensity, eventually becoming fully developed hurricanes under the proper conditions.

"This development may require only a day or may last more than a week," he says. "Once underway, though, it may last anywhere from a day to a month."

A hurricane's destruction is roughly centered on the path of the eye of the storm, but the greatest damage is on the right side of the storm. The width of this path depends on the individual hurricane. It can be as little as a mile or, in large hurricanes, the damage can extend along the shore for more than 100 miles. The damage path narrows as the storm moves inland and weakens, but significant damage has occurred hundreds of miles inland.

#### Eye Of The Hurricane

At the center of all this devastation is the eye of the hurricane. The eye corresponds to the low pressure center of the storm. "Its radius may be a few miles or tens of miles," Thompson says. "But the average is about 10 miles." In the eye, winds are weak but seldom calm. Overhead, the clouds are thin with blue sky sometimes visible in patches. There is little or no rain. The air is warm or hot, and humid.

That calm scene quickly changes on the outer edge of the near-circular eye, Thompson says. There on the edge, the weak wind blends rapidly into the high-energy or high wind area of the hurricane. The strongest winds occur near the inner edge of the ring-shaped high-energy area. The width of the ring varies from a few miles to a few tens of miles, again averaging near 10 miles.

The actual value depends in part on the intensity and size of the hurricane. The wind speed drops more or less regularly to below hurricane strength near the outer edge of this ring. Very low-based and thick clouds and torrential rains are characteristic of the ring. The inner edge of the deep cloud mass or "wall cloud" forms the edge of the relatively clear, bowl-shaped or funnel-shaped eye of the storm. Merging with the outer edge of the wall cloud and high-energy area is the spiral rain band area.

The air in the spiral rain band area rotates counterclockwise about the storm center in the northern hemisphere and in the opposite



direction in the southern hemisphere, Thompson says. At the same time, there is a distinct inflow of the moist, warm air near the surface to replace the air rising upward in the wall cloud. Bands of heavy thunderstorm clouds tend to form along the wind flow lines; these bands spiral inward and merge with the wall cloud.

Smaller cumulus clouds and fragmented layer clouds develop between bands in the lower part of the atmosphere. In the layers between about eight miles and 12 miles above the surface, the air is flowing outward from the wall cloud. This outward-flowing air is saturated and contains extensive layer clouds, which extend hundreds of miles from

the storm center.

#### Spiral Rain Bands

The winds near the surface decrease outward from the inner edge of the spiral rain band area, dropping to perhaps 20 to 30 mph on the outer edge of the area. Even so, he says, there may be some locally strong winds reaching speeds near 74 mph associated with the thunderstorms of the spiral rain bands.

The outer edge of the spiral rain band area merges gradually with the fringes of the storm. Thompson says the diameter of the outer ring or fringe of the hurricane depends mostly on the size and intensity of the other





Dan Hardy/Houston Post

parts.

The winds of the outer fringe are just slightly above the normal winds for the area. The winds begin the adjustment to the inward spiral flow of the hurricane. The normal cumulus cloud regime of the tropical oceans tends to be suppressed in parts of the fringes, so the sky may be nearly clear. In some portions of the storm, the high, outward-flowing clouds of the spiral rain band may be visible.

#### Keys To Safety

The key to seeing a hurricane through safely is knowing what you will do before the storm arrives. Advanced planning based

on whether you stay in or leave your residence will give you the edge you need to deal with such storms.

Texas A&M University's Sea Grant College Program asks you to use our decision guidelines and hurricane evacuation checklists included in this report if you're planning to leave. The safety tips and severe weather terms are intended to help you protect yourself from hurricanes, tornadoes, and thunderstorms and lightning.

In the event of a hurricane, please stay tuned to a local radio or television station for the latest official advisories, warnings and bulletins for emergency information and instructions. ■

## GLOSSARY

**Coastal Flood Watch:** An alert that significant wind-forced flooding is to be expected along low-lying coastal areas if weather patterns develop as forecast.

**Coastal Flood Warning:** A warning that significant wind-forced flooding is imminent along low-lying coastal areas.

**Eye:** The relative calm area in the center of a storm. Winds are light in this area and the sky often is only partly covered by clouds.

**Gale Warning:** A warning of sustained winds within the range of 39 to 54 mph (34 to 47 knots).

**Landfall:** The position at a seacoast where the center of a hurricane passes from sea to land.

**Local Statement:** A public release prepared by a Weather Service Office in or near a threatened area given specific details to protect life and property in the office's area of responsibility.

**Hurricane:** A tropical cyclone with sustained winds of 74 mph or greater.

**Hurricane Advisories:** Messages issued by the National Hurricane Center in Miami which summarize all coastal warnings that are in effect, including hurricane watches. In addition to a description of the storm, its position, anticipated movement and prospective threat are given.

**Hurricane Watch:** The first alert when a hurricane poses a possible, but as yet uncertain, threat to a certain coastal area. Small craft advisories are issued as part of a hurricane watch advisory.

**Hurricane Warning:** Notice that within 24 hours or less a specified coastal area may be subject to (a) sustained winds of 74 mph or higher and/or (b) dangerously high water or a combination of dangerously high water and exceptionally high waves, even though expected winds may be less than hurricane force.

**Severe Thunderstorm Watch:** Indicates that conditions are right for lightning, damaging winds greater than 58 mph, hail and/or heavy rain.

**Severe Thunderstorm Warning:** Indicates that severe thunderstorms have been sighted or indicated on radar.

**Storm Warning:** A warning of sustained winds in the range of 55 to 73 mph (48 to 63 knots) inclusive.

**Storm Surge:** An abnormal rise in the level of the sea produced by a hurricane or tropical storm. This inundation is usually responsible for the greatest loss of life and destruction of property.

**Tornado Watch:** Indicates that weather conditions are right for a tornado to develop and the sky should be watched.

**Tornado Warning:** Indicates a tornado has been sighted or is indicated on radar.

**Tropical Disturbance:** A moving area of thunderstorms of tropical origin that maintains its identity for 24 hours or more.

**Tropical Depression:** A rotary circulation at the surface of the water with sustained wind speed of 38 mph or less.

**Tropical Storm:** Distinct rotary circulation with sustained wind speeds of 39 to 73 mph.

# EVACUATION



Betty Teich-Hausler Post

**W**hen a hurricane is threatening, it's just as important to know when to stay put as to know how soon to leave. That's a conclusion Carlton Ruch, research scientist with the Research Division of Texas A&M's College of Architecture and Environmental Design, makes with certainty.

He has spent the past seven years heading a research team studying evacuation and relocation plans for the Texas Gulf coast. The work began with a model hurricane flood relocation plan for Galveston, Brazoria and southern Harris counties in 1979. That initial study eventually included Chambers and Fort Bend counties as well.

"If everyone in those five counties subject to possible storm surge flooding in a major hurricane were told to evacuate at the same time," Ruch explains, "there could be nearly 200,000 vehicles on the roads at once.

"The roads can't handle that many vehicles at a given time," he says. "You have to know which people to get out first, and which ones can either stay at home or wait until later."

The evacuation studies evolved from increasing awareness of potential relocation problems should a major hurricane strike the Texas Gulf coast. The Texas Legislature passed a resolution in the late 1970's that

encouraged development of such a plan for high population areas. Galveston, Brazoria, Harris, Fort Bend and Chambers counties were selected for the initial study since they encompass nearly 3,500 square miles of land area and have combined populations of nearly 3 million people—nearly a fourth of the state's entire population.

The original study was funded by Texas A&M's Sea Grant College Program and the federal Office of Coastal Zone Management through the Texas Energy and Natural Resources Advisory Council. Subsequent studies have been funded by the Governor's Division of Emergency Management. Each study has been coordinated by the Division of Emergency Management with local officials, the National Weather Service, Texas Department of Highways and Public Transportation, Texas Department of Public Safety, and The American Red Cross.

## Planning Tools

"Mayors and county judges are the only people who can recommend evacuation," Ruch explains. "Our studies aren't policy documents, they are simply planning tools or handbooks for these officials. We can't order evacuations, but we can give officials a handle on how much time remains before it

is too late to make a decision to recommend evacuation.

"Because of the many hazards associated with evacuating people over a congested highway system, it is best that people in "safe" areas not be encouraged to leave and add to the traffic unless they do so before traffic conditions become critical. Our reports make this point, although, here again, local officials have to make the final decision," he says.

As an example of the time needed to evacuate a particular area, Ruch says the initial study estimated it might take as little as three hours or as long as from 14 to 26 hours, depending on the severity of traffic jams, for vehicles leaving Galveston Island to reach safety in or beyond the Houston area.

## Evacuation Studies

"There are still problems with this estimate," Ruch says. "since there is no way of accurately estimating the traffic delays in Houston resulting from the additional evacuation vehicles being added to an already overloaded transportation network."

Evacuation studies have been completed for three areas of the Texas coast in addition

to the five-county, Houston-Galveston region. The Corpus Christi area study includes Aransas, Kenedy, Kleberg, Nueces, Refugio and San Patricio counties, the Beaumont-Port Arthur-Orange study covers Hardin, Jasper, Jefferson, Newton and Orange counties, and the Brownsville area study includes Cameron and Willacy counties.

Each study includes five phases. Computer programs that simulate hurricanes are run by the National Hurricane Center to indicate probable wind speeds and storm surge penetration for specific locations. The study area is then divided into zones, with more vulnerable areas designated evacuation zones and less vulnerable areas contingency zones. Evacuation times are then computed for each zone.

Evacuation route cutoff times are computed in hours before anticipated landfall for each zone by hurricane type for both surge penetration and wind intensity. Five conditions determine cutoff times—low tide flooding, mean sea level flooding, high tide flooding, car-tipping wind gusts and truck-tipping wind gusts.

### Capacity To Escape

"Once we have this information, we then estimate the number of hours it will take to evacuate people living in each zone," Ruch says. "We base this estimate on the probable number of evacuating vehicles and on the capacities of specific roads."

As an example, Ruch describes a hypothetical situation if a storm were approaching Galveston. "Assume there is a 120 mph hurricane in the Gulf some 250 miles south of Galveston that is heading due north at 5 mph. Since the wind speed is less than 130 mph, we know that the storm surge will be confined to the evacuation zones in the Houston-Galveston area, and our time estimates tell us it will take approximately 14 hours to evacuate the island and reach a safe location. We then add three hours for the estimated time required for warning, preparation and monitoring.

"There basically is just one evacuation route from Galveston, the causeway to the mainland," Ruch says. "This means we must determine when the causeway will be blocked by storm conditions. Flooding isn't the primary problem here. Sixty-five mph wind gusts will shut the causeway down long before flooding becomes a factor."

Wind gusts will reach 65 mph in Galveston 17.5 hours before landfall with this hypothetical hurricane, so Ruch adds this time to the original 17 hours needed for evacuation. From this, he determines that evacuation for this type of hurricane would need to begin 34.5 hours before landfall.

"If our storm is 250 miles away and mov-

ing at 5 miles per hour," Ruch goes on, "we can expect landfall in 50 hours. We then subtract the 34.5 hours from 50 hours to know there are 15.5 hours before it is necessary to make an evacuation decision."

### Potential Problems

During this intervening time, local officials analyze potential traffic problems, the desirability of evacuating during daylight hours, the unpredictability of hurricane intensification or weakening, variances in forward movement speed, direction changes, and evacuation route blockage by unexpected rainfall.

There is no way of accurately predicting rainfall during a hurricane, so the evacuation studies cannot calculate rain-induced flooding. Ruch points out, however, that several low areas and key intersections in Houston have a history of flooding during heavy downpours and that these factors also must be considered in computing evacuation time.

An even greater problem, according to Ruch, is the fact that officials often are forced to make a decision before the actual time and location of hurricane landfall are known. The National Hurricane Center normally provides 16 to 24 hours of warning before a hurricane makes landfall, but storms can change abruptly and leave as little as 10 hours' warning, Ruch says.

"We really saw this with Allen (in 1980)," Ruch says. "It was dubbed the 'storm of the century' when it was still in the Gulf and gave every indication that it was going to come across the upper Texas coast with a vengeance, probably at dawn on a Saturday morning. Local officials felt they had no choice but to order an evacuation beginning Friday afternoon.

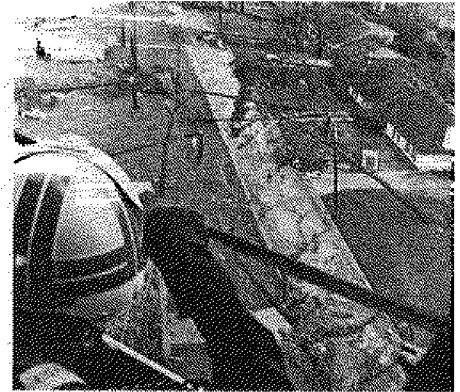
### Fickle Allen

"But Allen was fickle. It wound up making landfall in a relatively unpopulated area north of Brownsville and had lost nearly all of its punch by that time.

Some 250,000 people were evacuated, primarily from the upper Texas coast that didn't even get a brief shower in some areas. There were numerous complaints from those who left—needlessly in their opinions—but local officials can rely only on possibilities. There is very little certainty about hurricanes you can only prepare for what could possibly happen. The key is to make the decision of least regret."

Each evacuation study is being followed by a vulnerability analysis, which uses data from the simulated hurricane runs to indicate the potential damage or loss that could result from both storm surge and winds, and by contingency planning, which indicates what action must be taken to reduce the losses identified by vulnerability analysis. ■

## PROBABILITY STATEMENTS



As tropical storms or hurricanes move closer to the U.S. coastline, the National Hurricane Center will begin to issue *probability statements* along with the more familiar hurricane watch and warning announcements. Probability statements are used to predict the chances of a specific storm striking a given area of the coastline.

Using past forecast error statistics and a hurricane's forecasted movement, the National Hurricane Center assesses the probability of a given hurricane affecting a particular location. As the forecast period shortens, the accuracy of the prediction increases. Predictions are expressed in percentages. During the movement of an actual storm, you may hear television or radio announcers say there is a 40 percent or 70 percent chance that the storm will affect a specific coastal area. In Texas, probability statements will be issued for Port Arthur, Galveston, Port O'Connor, Corpus Christi and Brownsville.

Probability statements are intended primarily for government officials and other decisionmakers, and should not be used as the sole factor in deciding when or if evacuation should occur. While the statements indicate the likelihood that a storm will affect a given area, they do not contain information on what conditions may be generated by that storm.

# SAFETY



Craig Harbilly-Houston Post

## **BEFORE A HURRICANE THREATENS:**

### **Know Elevation of Your Home Above Sea Level**

This information is available from local Emergency Management officials. Your nearest Weather Station office can supply flood-stage data for area streams and bayous.

### **Learn Potential Maximum Storm Surge**

Find out if your home is subject to storm surge (tidal) flooding. Information about the potential for inland flooding and storm surge is available through the nearest Weather Station office.

### **How Safe Is Your Home?**

Plan to relocate during a hurricane emergency if you live near the seashore. If you live in a mobile home, always plan to relocate.

### **Know Location of Nearest Shelter**

Emergency Management or Red Cross personnel can give you the location of the shelter nearest your home and explain what you should bring with you.

Plan for your family's safety. Know how to contact family members should the need

arise.

### **Plan Route to Safety If You Must Leave**

Plan your escape route early. Check with Emergency Management personnel for low points and flooding history of your route. Check the number of hours it could take you to evacuate to a safe area during peak evacuation traffic.

### **Inventory Your Property**

A complete inventory of personal property will help in obtaining insurance settlements and/or tax deductions for losses. Inventory checklists can be obtained from many sources, including your insurance representative. Do not trust your memory. List descriptions and take pictures. Store these and other important insurance papers in waterproof containers or in your safety deposit box.

### **Check Insurance Coverage**

Review your insurance policies and your coverage to avoid misunderstandings later. Take advantage of flood insurance. Separate policies are needed for protection against wind and flood damage, which people frequently do not realize until too late. Do not wait until a hurricane is in the Gulf—by

then, it is too late. When a storm is heading to shore, insurance offices are too busy preparing for the emergency and won't be able to respond to individual requests, and insurance cannot be obtained.

## **WHEN A WATCH IS ISSUED:**

### **Make Plans Early Listen Constantly to Radio or TV**

Monitor storm reports and keep a log of hurricane position. Remember—evacuation routes sometimes can be closed up to 20 hours before landfall by wind gusting or storm surge flooding.

If considering moving to a shelter, make arrangements for all pets. Pets are not allowed in shelters.

Refill needed prescriptions.

If evacuation has not already been recommended, consider leaving the area early to avoid long hours on limited evacuation routes.

### **Check Supplies**

#### **■ Transistor Radio with Fresh Batteries**

A radio will be your most useful source of information. Have enough batteries to last

several days. There may be no electricity.

#### ■ Flashlights, Candles or Lamps, and Matches

Store matches in a waterproof container. Have enough lantern fuel for several days, and know how to use it safely.

#### ■ Full Tank of Gasoline

Never let your vehicle gas tank be less than half-full during hurricane season. Fill the tank as soon as a hurricane watch is posted. Remember—when there is no electricity, gas pumps won't work.

#### ■ Canned Goods and Non-perishable Foods

Store packaged foods which can be prepared without cooking and need no refrigeration. There may be no-electricity or gas.

#### ■ Containers for Drinking Water

Have clean, air-tight containers to store sufficient drinking water for several days. The city supply will probably be interrupted or contaminated.

#### ■ Materials to Protect Glass Openings

Have shutters or lumber to protect large windows and doors and masking tape for use on small windows.

#### ■ Materials for Emergency Repairs

Your insurance policy may cover the cost of materials used in temporary repairs so keep all receipts. These also will be helpful for any income tax deductions.

### WHEN A WARNING IS ISSUED:

#### Continue Listening to Radio or TV

Continue to monitor hurricane position, intensity and expected landfall.

#### If You Live in a Mobile Home

Check tie-downs and leave immediately for a safer place. Mobile homes are not safe in hurricane force winds.

#### Prepare for High Winds

Brace your garage door. Lower antennas. Be prepared to make repairs.

#### Anchor Outside Objects

Garbage cans, awnings, loose garden tools, toys and other loose objects can become deadly missiles. Anchor them securely.

#### Protect Windows and Other Glass

Board up or shutter large windows securely. Tape exposed glass to reduce shattering. Draw drapes across windows and doors to protect against flying glass if shattering does occur.

#### Move Boats on Trailers Close to House

Fill boats with water to weight them down. Lash securely to trailer and use tie-downs to anchor the trailer to the ground or house.

#### Check Mooring Lines of Boats in Water—Then leave them.

#### Store Valuables and Personal Papers

Put irreplaceable documents in waterproof containers and store in the highest possible spot. If you evacuate, be sure to take them with you.

### Prepare for Storm Surge, Tornadoes and Floods

Storm surge, tornadoes and flash floods are the worst killers associated with a hurricane. During a tornado warning, seek shelter inside, below ground level if possible, or in an interior hallway, closet or bathroom on ground level. If outside, move away at right angles from the tornado; if escape is impossible, lie flat in a ditch or low spot. The surge of ocean water plus flash flooding of streams and rivers due to torrential rains combine to make drowning the greatest cause of hurricane deaths.

#### Check Your Survival Supplies Again

### IF YOU STAY AT HOME:

#### Stay Indoors

Please stay in an inside room away from doors and windows. Don't go outside in the brief calm during passage of the eye of the storm. The lull sometimes ends suddenly as winds return from the opposite direction. Winds can increase in seconds to 75 mph or more.

#### Protect Property

Without taking any unnecessary risks, protect your property from damage. Temporary repairs can reduce your losses.

#### Stay Away from Windows, Glass Doors

Move furniture away from exposed doors and windows.

#### Stay Tuned to Media Broadcasts

Keep a radio or television tuned for information from official sources. Unexpected changes can sometimes call for last minute relocations.

#### Remain Calm

Your ability to meet emergencies will help others.

### IF YOU MUST EVACUATE:

#### Know Where You Are Going

Please leave early, in daylight, if possible.

**Move your most valuable possessions that you can't take with you to higher points within your home.**

#### For Shelters

Take blankets or sleeping bags, flashlights, special dietary foods, infant needs and lightweight folding chairs.

Register every person arriving with you at the shelter.

Do not take pets, alcoholic beverages or weapons of any kind to shelters.

Be prepared to offer assistance to shelter workers if necessary, and stress to all family members their obligations to keep the shelter clean and sanitary.

#### Don't Travel Farther than Necessary

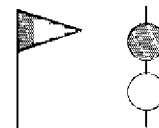
Roads may be jammed. Don't let your stranded auto become your coffin.

#### Lock Windows and Doors

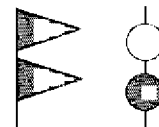
Turn off gas, water and electricity in your

Colored pennants and lights are displayed in some ports and areas of the Texas coast to warn of hazardous sea conditions. Modern technology, however, has reduced the number of flag stations needed along the coast. Now emphasis is placed on continuous marine broadcasts transmitted at 162.55 MHz.

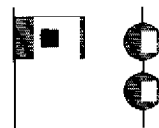
**Small Craft Advisory:** One RED pennant displayed by day and a RED light over a WHITE light at night to indicate that winds and seas, or sea conditions alone, considered dangerous to small craft operations are forecast. Winds may range as high as 38 mph (33 knots).



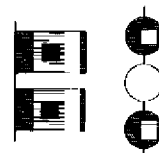
**Gale Warning:** Two RED pennants displayed by day and a WHITE light above a RED light at night to indicate winds within the range of 39 to 54 mph (34 to 47 knots) are forecast for the area.



**Storm Warning:** A single square RED flag with a BLACK center displayed during daytime and two RED lights at night to indicate winds within the range 55 to 73 mph (48 to 63 knots) are forecast for the area.



**Hurricane Warning:** Two square RED flags with BLACK center displayed during the day and WHITE light between two RED lights at night to indicate that winds 74 mph (64 knots) and above are forecast for that area.



home. Check to see that you have done everything possible to protect your property from damage and loss.

#### **Take Survival Supplies With You**

- First-aid kit
- Canned or dried provisions, can opener, spoons, etc.
- Bottled water
- Extra family medications, prescriptions
- Spare eyeglasses, hearing aids and batteries, if needed.

#### **Keep Important Papers with You At All Times**

- Driver's license and other identification
- Insurance policies
- Property inventory
- Medic-alert or device to convey special medical information
- Maps to your destination

#### **Take Warm, Protective Clothing**

### **AFTER THE HURRICANE:**

#### **If You Are Evacuated**

Please delay your return until it is recommended or authorized by local authorities.

#### **Beware of Outdoor Hazards**

Watch out for loose or dangling power lines, and report them immediately to proper authorities. Many lives are lost through elec-

trication.

#### **Walk or Drive Cautiously**

Debris-filled streets are dangerous. Snakes and poisonous insects will be a hazard. Washouts may weaken road and bridge structures which could collapse under vehicle weight.

#### **Guard Against Spoiled Food**

Food may spoil if refrigerator power is off more than a few hours. Freezers will keep food several days if doors are not opened after power failure, but do not refreeze food once it begins to thaw.

#### **Do Not Use Water Until Safe**

Use your emergency supply or boil water before drinking until official word that the water is safe. Report broken sewer or water mains to the proper authorities.

#### **Take Extra Precautions to Prevent Fire**

Lowered water pressure in city mains and the interruption of other services may make fire fighting extremely difficult after a hurricane.

### **THE RECOVERY:**

#### **Insurance**

Insurance representatives will be on the scene immediately following a major disaster to speed up the handling of claims. Notify

your insurance agent or broker of any losses—and leave word where you can be contacted.

#### **Take Steps to Protect Property**

Make temporary repairs to protect property from further damage or looting. Use only reputable contractors (sometimes in the chaotic days following a disaster, unscrupulous operators will prey on the unsuspecting). If possible check contractors through the Better Business Bureau. Keep receipts for materials used.

#### **Be Patient**

Hardship cases will be settled first by insurance representatives. Don't assume your settlement will be the same as your neighbor's. Policy forms differ and storm damage is often erratic. In a major catastrophe, the insurance industry will have emergency offices and extra manpower to expedite claim settlements and to speed recovery. Everyone cannot be first.

#### **It Takes a Team Effort**

Responsibility for the clean-up falls to numerous local, state and federal agencies. A local Emergency Management coordinator (the mayor, county judge or a designated representative) will be on hand to help residents in this effort. ■

**H**urricanes are categorized according to a disaster-potential scale developed by Herbert Saffir, Dade County, Fla., consulting engineer, and Dr. Robert H. Simpson, former National Hurricane Center director. The disaster-potential numbers are not forecasts, but are based on observed conditions at a given time in a hurricane's lifespan.

**Force One:** Winds of 74 to 95 mph. Damage primarily to shrubbery, trees, foliage, unanchored mobile homes and, possibly, poorly constructed signs. OR—Storm surge 4- to 5-feet above normal. Low-lying coastal roads inundated, minor pier damage, some small craft in exposed anchorages torn from moorings.

**Force Two:** Winds of 96 to 110 mph. Considerable damage to shrubbery and tree foliage, some trees blown down. Major damage to exposed mobile homes and poorly constructed signs. Some damage to roofs, windows and doors. No major damage to buildings. OR—Storm surge 6- to 8-feet above normal. Coastal roads and low-lying escape routes cut by rising water 2 to 4 hours

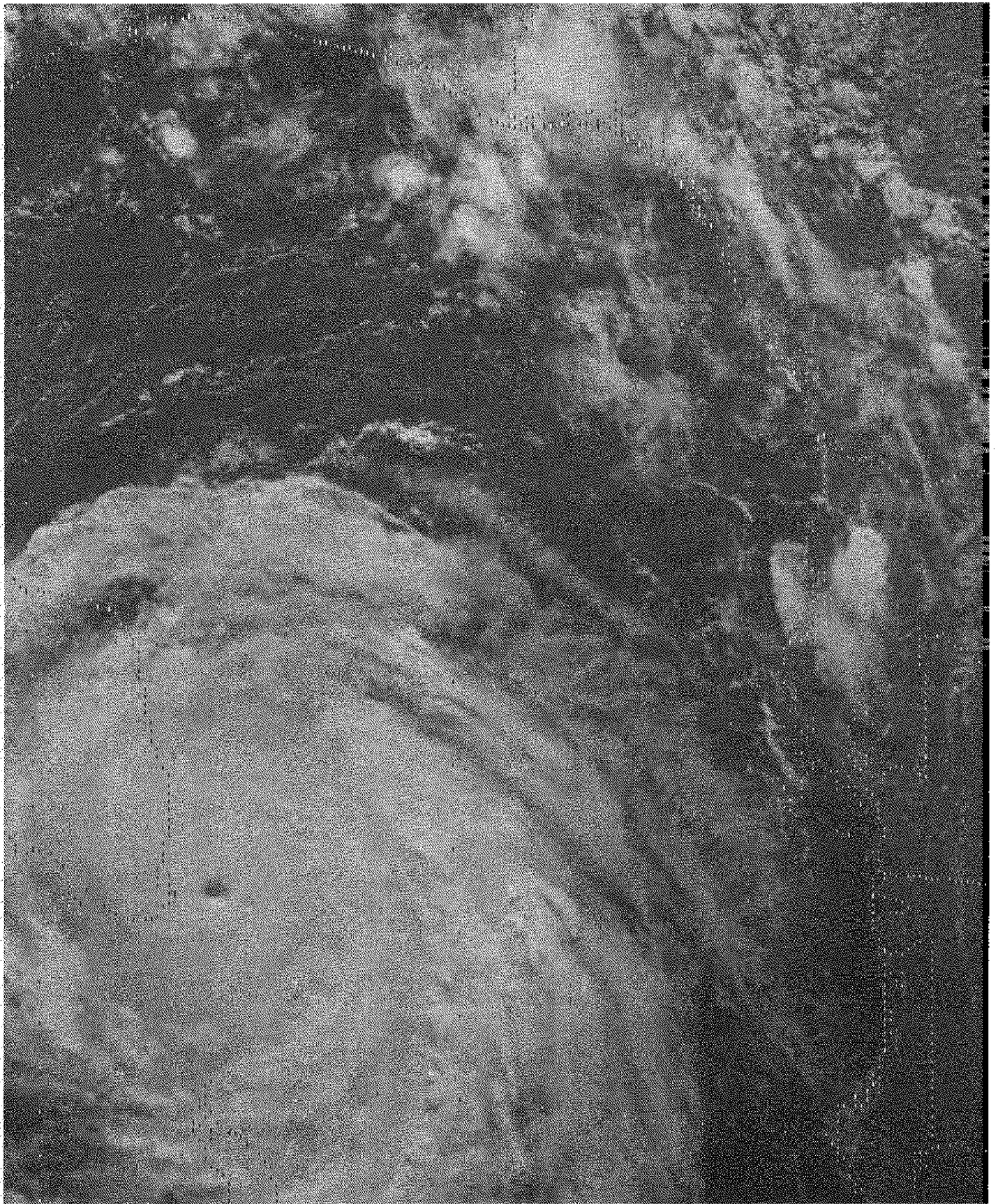
before arrival of hurricane center. Considerable damage to piers. Marinas flooded and small craft in unprotected anchorages torn from moorings. Evacuation of some shoreline residences and low-lying island areas required.

**Force Three:** Winds of 111 to 130 mph. Foliage torn from trees, large trees blown down. Practically all poorly constructed signs blown down and mobile homes destroyed. Some damage to roofs, windows and doors and some structural damage to small buildings. OR—Storm surge 9- to 12-feet above normal. Serious flooding at coast and many smaller structures near coast destroyed. Larger structures battered by waves and floating debris. Low-lying escape routes cut by rising water 3 to 5 hours before hurricane center arrives. Flat terrain 5-feet or less above sea level flooded 8 miles inland or more. Evacuation of low-lying residences within several blocks of shoreline possibly required.

**Force Four:** Winds of 131 to 155 mph. Shrubs and trees blown down, all signs down. Extensive damage to roofs, windows and doors. Complete destruction of mobile homes. OR—Storm surge 13- to 18-feet above nor-

mal. Flat terrain 10 feet or less above sea level flooded as far as 6 miles inland. Major damage to lower floors of structures near shore due to flooding and battering by waves and floating debris. Low-lying escape routes cut by rising water 3 to 5 hours before hurricane center arrives. Major erosion of beaches. Massive evacuation of all residences within 500 yards of shore possibly required, and of single-story residences on low ground within 2 miles of shore.

**Force Five:** Winds greater than 155 mph. Shrubs and trees blown down, all signs down and complete destruction of mobile homes. Extensive shattering of glass in windows and doors and complete failure of roofs on many residences and industrial buildings. Small buildings overturned or blown away. OR—Storm surge greater than 18-feet above normal. Major damage to lower floors of all structures less than 15-feet above sea level within 500 yards of shore. Low-lying escape routes cut by rising water 3 to 5 hours before hurricane center arrives. Massive evacuation of low-lying residential areas within 5 to 10 miles of shore possibly required. ■



# SEGURIDAD



Robert Mitchell

## ANTES DE QUE UN HURACAN AMENACE

### Sepa la Elevación de su Casa en Relación al Nivel del Mar

Esta información la puede obtener en las oficinas locales de Control en Caso de Emergencias. La oficina de Servicio de Meteorología más cercana puede proveer información sobre el nivel de las aguas en canales y arroyos o riachuelos del área.

### Informese de la Posible Altura Máxima de la Oleada

Informese si su casa puede ser afectada por inundaciones causadas por las oleadas.

Información sobre la posibilidad de inundaciones tierra adentro puede ser obtenida en la oficina de Servicio de Meteorología más cercana a su hogar.

### ¿Cuán Segura está su Casa?

Planee relocalizar (moverse) durante una emergencia de huracán, si usted vive cerca de la costa. Si usted vive en una casa móvil siempre planee relocalizar.

### Sepa Donde Está el Lugar de Refugio más Cercano

La Administración de Emergencia o la Cruz Roja puede informarle dónde está el

lugar de refugio más cercano a su casa y también le puede informar qué debe traer.

Planee la seguridad de su familia. Sepa siempre como comunicarse con sus familiares en caso de que una emergencia se presente.

### Planee la Ruta de Seguridad en Caso de que Tenga que Salir

Planee su ruta de escape con tiempo. Infórmese con el personal de Administración de Emergencia de los puntos bajos y de la historia de inundaciones de su vecindario y donde ocurren las inundaciones. Sepa cuanto tiempo tardará en salir de su casa y llegar a



un lugar seguro cuando el movimiento y el tráfico es máximo.

### Haga Inventario de su Propiedad

Un completo inventario de su propiedad personal le ayudará a recibir pago por seguro o deducciones de impuestos por sus pérdidas. Listas de inventario se pueden conseguir de muchas formas, inclusive de sus representantes de seguro. No dependa de su memoria. Enumere descripciones y tome fotos. Guarde estos y otros documentos importantes de Seguro en un envase a prueba de agua o en su caja de seguridad.

### Compruebe su Cubierta de Seguro

Para evitar malos entendidos, conozca sus pólizas y cubiertas de seguro. Aprovechese de seguros contra inundaciones. Para protegerse en contra de daños causados por vientos o inundaciones se necesitan dos pólizas distintas y mucha gente no se da cuenta de esto hasta muy tarde. Cuando la tormenta viene hacia la costa, las oficinas de Seguros estarán muy ocupadas preparándose para la emergencia y no podrán responder a peticiones individuales, y seguros no podrán ser obtenidos.

## CUANDO UNA VIGILANCIA ESTA EN EFECTO

### Haga Planes con Anticipación Escuche constantemente la radio o televisión

Esté al tanto de los reportes de la tormenta y mantenga apuntes en todo momento de la posición del huracán. Recuerde que a veces las rutas de evacuación pueden ser cerradas hasta con 20 horas de anticipación a la llegada de las ráfagas de viento o de la inundación debida a la oleada.

Si está considerando moverse a un refugio haga arreglos para los animales caseros. En los refugios no se permiten animales. Si está tomando medicamentos tenga suficiente antes de ir al refugio. Si la evacuación no ha sido todavía recomendada, considere salir con tiempo para así evitar largas horas de espera en las rutas limitadas.

### Chequee los Abastecimientos • Radio Transistor con Baterías Nuevas

Un radio es su medio de información más útil. Tenga suficientes baterías (pilas) que le duren varios días. Puede que no haya electricidad.

### • Linternas de Baterías (Pilas), Velas o Lámparas con Combustible y Cerillos (fósforos)

Guarde cerillos (fósforos) en un envase a prueba de agua. Tenga suficiente combustible para la lámpara por varios días y sepa usarla cuidadosamente.

### • Llene el Tanque de Gasolina

Nunca deje que el tanque de su vehículo

tenga menos de medio tanque durante temporada de huracanes. Llene el tanque tan pronto como la vigilancia sea puesta en efecto. **Recuerde**—cuando no hay electricidad las bombas de gasolina no funcionan.

### • Comidas la Lata y Comidas no Perecederas

Almacene comida envazada al vacío que no necesite ser cocida ni refrigerada. Puede que no haya ni electricidad ni gas.

### • Envase Agua Portable

Tenga agua limpia en envases herméticamente cerrados y suficiente para varios días. El abastecimiento de agua de la ciudad puede ser interrumpido o contaminado.

### • Material para Proteger Aberturas de Vidrio

Asegure bien o tenga madera para proteger las ventanas grandes y puertas y cinta adhesiva para usarse en las ventanas pequeñas.

### • Material para Reparaciones de Emergencia

Puede que su póliza de seguros cubra los gastos hechos en materiales, así que guarde todos sus recibos. Esto también puede ser deducible de sus impuestos.

## CUANDO UN AVISO DE HURACAN ESTA EN EFECTO

### Continue Escuchando la Radio o Televisión

Esté al tanto de los reportes de la posición del huracán, su intensidad y cuando se espere en tierra.

### Si Usted Vive en una Casa Mobil

Chequee que las ventanas estén bien sujetas y atadas y salga inmediatamente a un lugar seguro. Una casa mobil no es un lugar seguro contra los vientos fuertes de un huracán.

### Prepárese Contra Vientos Fuertes

Ate su puerta del garage. Baje las antenas y prepárese para hacer arreglos.

### Asegure Todos los Objetos Afuera

Los basureros, pabellones, herramientas de jardín, juguetes al igual que cualquier objeto sujeto afuera puede convertirse en un proyectil peligroso. Asegure todas estas cosas bien o guardelas adentro.

### Proteja Ventanas y Vidrieras

Asegure con madera todas las ventanas grandes. Ponga cinta adhesiva a los vidrios para así evitar que se rompan. Proteja las ventanas con las cortinas para evitar que si el viento las rompe, los vidrios no entren.

### Mueva Botes o Remolques (o vagones) cerca de la Casa

Llene los botes con agua para evitar que el viento los levante. Asegure bien los re-

## Terminos Relacionados con Huracanes

**Ojo**—El área de la calma relativa en el centro de la tormenta. Los vientos son suaves en esta área y el cielo está parcialmente nublado.

**Aviso de Ventarrones**—Aviso de vientos sostenidos de 39 a 54 millas por hora (mph).

**Huracán**—Un ciclón tropical con vientos sostenidos de 75 mph o más.

**Advertencias de Huracanes**—Reportes puestos en efecto por el Centro Nacional de Huracanes en Miami, Florida, el cual resume todos los avisos costeros que están en efecto, incluyendo vigilancias de huracán. Además de la descripción de la tormenta, también incluye posibles amenazas.

**Vigilancia de Huracanes**—La primera alerta cuando un huracán posee una posible, pero todavía insegura, amenaza a un área costera en particular. Advertencia a las embarcaciones pequeñas son puestas en efecto como parte de la advertencia de vigilancia de huracán.

**Aviso de Huracán**—Aviso de que en 24 horas o menos un área costera específica puede estar sujeta a (a) vientos sostenidos de 74 mph o más y/o (b) el peligroso alto nivel del agua y olas excepcionalmente altas, aunque vientos que no hayan alcanzado fuerza de huracán pueden ser esperados.

**Entrada a Tierra**—La posición en la costa por donde el centro u ojo del huracán entra a tierra.

**Informe Local**—Un anuncio al público preparado por la Oficina de Servicio de Meteorología en o cerca del área amenazada para proveer instrucciones de como protegerse uno y su propiedad.

**Aviso a Embarcaciones Pequeñas**—Cuando un huracán o tormenta amenaza las áreas costeras las embarcaciones pequeñas deben mantenerse en puerto seguro o no aventurarse a mar abierto.

**Oleada**—Un anormal levantamiento en el nivel del mar causado por un huracán o tormenta tropical. Esta inundación es usualmente responsable por la gran pérdida de vidas y destrucción de propiedad.

**Aviso de Tormenta**—Cuando esta asociado con un huracán o tormenta tropical, un aviso de vientos sostenidos en el rango es de 55 a 73 mph, inclusive.

**Disturbios Tropicales**—Un área mobile con fuertes aguaceros asociados con tronadas de origen tropical que mantienen su identidad por 24 horas o más.

**Depresión Tropical**—Rotación en círculo con vientos de 39 a 73 mph.

**Tormenta Tropical**—Una distintiva circulación que rota con vientos sostenidos de 39 a 73 mph.

molques y átelos bien de la casa o de la tierra.

### **Chequee las Ataduras de los Botes en Agua... y ALEJESE DE ELLOS**

#### **Asegure Propiedades de Valor y Documentos Personales**

Ponga documentos irremplazables en envases a prueba de agua y póngalos en un lugar lo más alto posible. Si tiene que evacuar de su hogar no olvide llevarse los.

#### **Prepárese contra Oleadas, Tornados e Inundaciones**

*Oleadas, tornados e inundaciones repentinas son los peores asesinos asociados con un huracán.* Durante un aviso de tornado, busque refugio en sótanos si es posible, en un pasillo interior, baño o en un closet. Si se encuentra afuera muevase en ángulos rectos al tornado, si es imposible escapar, acuestese en el suelo o en una zanja. La oleada del mar en sumada a las inundaciones repentinas de arroyos o ríos debido a lluvias torrenciales se convinan para causar que una persona pueda ahogarse, esto es la causa mayor de muertes en un huracán.

#### **Chequee Sus Comestibles en Caso de Emergencia Otra Vez**

## **SI USTED SE QUEDA EN CASA**

#### **Manténgase Siempre Adentro...**

... *En un cuarto alejado de las puertas y ventanas.* No vaya afuera en la calma temporal durante el paso del ojo del huracán. La calma generalmente termina de momento cuando empiezan vientos fuertes en dirección opuesta. Los vientos pueden aumentar en segundos a 75 millas por hora o más.

#### **Proteja su Propiedad**

Sin tomar ningún riesgo que no sea necesario proteja su propiedad contra daños. Arreglos tempranos pueden reducir sus pérdidas.

#### **Manténgase Alejado de Ventanas y Puertas**

Mueva todos los muebles lejos de las ventanas y puertas.

#### **Mantéga su Radio en Sintonía (Prendido)**

Tenga la televisión o radio sintonizada para recibir información de fuentes oficiales. Cambios inesperados pueden a veces requerir relocalizaciones en el último minuto.

#### **Manténgase en Calma**

Su habilidad para confrontar emergencias ayudará a otros.

## **SI TIENE QUE EVACUAR O SALIR**

#### **Sepa a Donde Va...**

... salga de día si es posible.

#### **Mueva las Propiedades más Valiosas**

que no pueda llevar consigo a un lugar alto en la casa.

#### **Para el Refugio**

Lleve cobijas, sacos para dormir, linternas, comidas dietéticas especiales y sillas plegadizas livianas.

Registre cada persona con usted en cuanto llegue al refugio.

No lleve bebidas alcohólicas, animales, ni ningún arma de fuego.

Esté preparado para ofrecer asistencia a empleados del refugio si es necesario e informe a cada miembro de su familia lo necesario e importante que es que mantengan el refugio limpio e higiénico.

#### **No Viaje Más de lo Necesario**

Los caminos pueden estar congestionados. No deje que su carro quede estancado pues se puede convertir en su propia tumba.

#### **Cierre con Seguro Puertas y Ventanas**

Cierre la llave del gas y el agua y desconecte la electricidad de su casa. Asegúrese de que usted a hecho todo lo posible por proteger su propiedad contra posibles daños o pérdidas.

#### **Lleve Comestibles y Utensilios para Sobrevivir**

- Primeros auxilios
- Provisiones enlatadas o secas, abridores de latas, cucharas, etc.
- Agua potable
- Medicamentos extras, prescripciones
- Un par de anteojos extras, audífonos y baterías (pilas) si son necesarias.

#### **Manténga con Usted Documentos Importantes en Todo Momento**

- Licencia de manejar y otras tarjetas de identificación
- Pólizas de seguro
- Información médica
- Inventario de propiedades
- Lleve su "Medic-alert" o lo necesario para dar la información médica necesaria
- Mapas hacia donde va

#### **Lleve Ropa Protectora y Que Abrigue**

## **DESPUES DEL HURACAN**

#### **Si usted ha sido evacuado...**

... no regrese a su casa hasta que las autoridades lo permitan.

#### **Esté Alerta a Peligros al Aire Libre**

Esté alerta a posibles cables eléctricos sueltos en el aire. Si nota algo así, repórtelo inmediatamente a las autoridades. Muchas vidas se pierden debido a electrocutamientos.

#### **Camine o Maneje Cuidadosamente**

Los escombros dejados en las calles por el huracán pueden ser peligrosos. Víboras e insectos venenosos pueden ser un peligro. A causa de los vientos y lluvias los derrumbes

pueden ceder por el peso de los vehículos.

#### **Cuidado con Comida Que se Haya Dañado**

Si no hay electricidad por varias horas es posible que ciertos alimentos se dañen. Si no se abre, el congelador mantiene comida en buenas condiciones por varios días, pero no vuelva a congelar comida una vez descongelada.

#### **No Tome Ni Use Agua Hasta Estar Seguro de Su Buena Condición**

Use el agua que almacenó para emergencias o hierva el agua antes de beberla y espere hasta que las autoridades notifiquen que el agua se puede usar. Reporte a las autoridades en caso de alcantarillas o tuberías quebradas.

#### **Tome Precauciones Extras para Prevenir Fuegos**

La disminución de la presión del agua en la cañería maestra y la interrupción de otros servicios pueden hacer difícil el apagar fuegos después de un huracán.

## **LA RECUPERACION**

#### **Seguros**

Los representantes de seguros estarán presentes inmediatamente después de un desastre para ayudarles con sus reclamaciones. Notifique a su agente de seguros cualquier daño o pérdida y deje dicho en donde pueden comunicarse con usted.

#### **Tome Medidas para Proteger Su Propiedad**

Haga arreglos temporeros para proteger su propiedad contra mayores daños. Use solamente contratistas de buena reputación (a veces después de desastres muchos empresarios sin escrúpulos se aprovechan de la ocasión para estafar a la gente). Si es posible infórmese de buenos contratistas por medio del "Better Business Bureau." Guarde los recibos del material comprado.

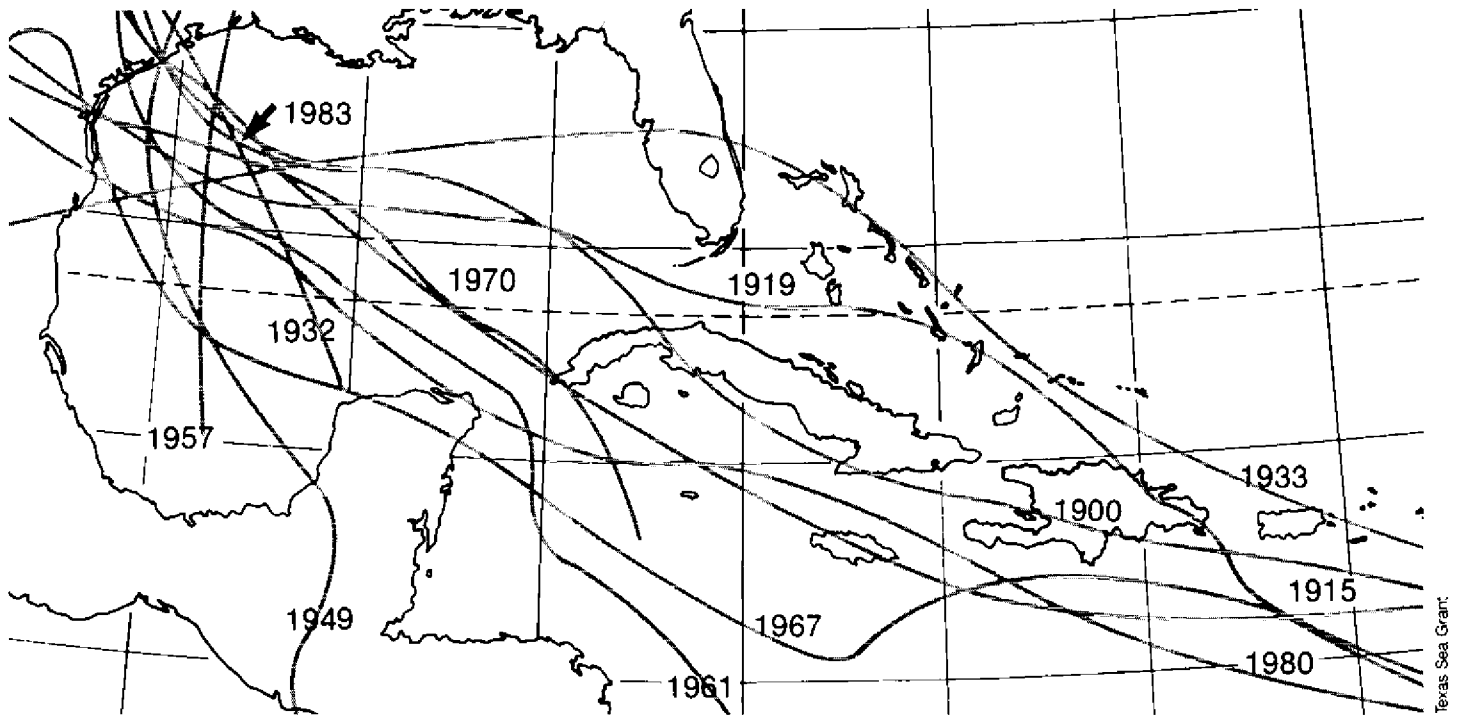
#### **Tenga Paciencia**

Casos de apuro serán manejados primeramente por los representantes de seguros. No piense que su pago será igual al de su vecino. Las pólizas varían y en muchos casos los daños de un lugar a otro varían también. En caso de una catástrofe, las agencias de seguros tendrán personal adicional para ayudar a ajustar y pagar por daños lo más pronto posible. Recuerde... no todo el mundo puede ser primero.

#### **Se Toma un Esfuerzo en Equipo**

La responsabilidad de limpiar es de las autoridades locales, estatales y federales. Un coordinador local de la Administración en caso de Emergencia (el juez, el alcalde o un representante designado) estará presente para ayudar a los residentes en este esfuerzo.■

# HISTORY



Texas Sea Grant

**H**ere is a list of major hurricanes that have battered the Texas coastline since the turn of the century.

**1900** — Aug. 27-Sept. 15: Galveston; 6,000 deaths, estimated 120 mph winds. The worst natural disaster in United States history, estimated damage from \$30 million to \$40 million. Principal damage and most loss of life caused by storm tide which inundated Galveston Island.

**1909** — July 21: Freeport; 41 killed and damage was estimated at \$2 million.

**1915** — Aug. 5-25: Texas and Louisiana, Galveston; 120 mph. winds, 275 deaths, \$56 million estimated damage. Twelve-foot storm tide flooded Galveston to a depth of 5- to 6-feet.

**1916** — Aug. 18: Corpus Christi; estimated damage at \$1.6 million, 220 deaths.

**1919** — Sept. 2-15: Florida, Louisiana and Texas; Also known as the Corpus Christi storm; 72 mph wind, 2287 deaths. \$20 million estimated damage. More than 500 casualties in ships lost at sea.

**1932** — Aug. 11-14: East Columbia; 40 deaths, 100 mph wind, \$7.5 million damage. Hurricane was small in diameter. Winds damaged rice and some cotton near the coast but accompanying rains helped parched inland areas.

**1933** — Aug. 28-Sept. 5: Brownsville; 40 deaths, 80 mph winds, \$12 million damage. Heavy property damage from Corpus Christi to northeastern Mexico; citrus crop virtually destroyed.

**1934** — July 21-25: Florida and Texas; Corpus Christi, 11 deaths, 52 mph winds, \$4.5 million damage.

**1941** — Sept. 16-25: Texas City; wind gusts of 83 mph, four deaths, \$6 million estimated damages. Very heavy crop damage. Most low exposed places evacuated in response to good warning, resulting in low casualty figure.

**1942** — Aug. 29-30: Matagorda Bay storm; eight deaths, \$26.5 million in estimated damages.

**1943** — July 27: Port Bolivar; 19 deaths, \$18.5 million estimated damages.

**1945** — Aug. 27: Matagorda Bay; three deaths, \$20.1 million in damages.

**1947** — Aug. 24: Galveston; one death, \$200,000 in damages.

**1949** — Sept. 27-Oct. 6: Freeport; 135 mph winds, two deaths, \$6.7 million in damages. Severe damage to agricultural crops.

**Audrey** — June 25-28, 1957: Texas to Alabama; Sabine Pass; 100 mph winds, 390 deaths, \$200 million damage. Storm surge of more than 12 feet caused flooding of the flat Louisiana coast by Gulf waters as far as 25 miles inland.

**Debra** — July 25, 1959: Galveston; \$7 million estimated damages, no deaths.

**Carla** — Sept. 3-15, 1961: Port O'Connor, Port Lavaca and Matagorda; 160 mph wind, estimated at 175 mph at Port Lavaca, 46 deaths, \$408 million in damage. Severe damage along wide expanse of Texas coast from unusually prolonged winds, high tides and flooding.

**Cindy** — Sept. 17, 1963: Made landfall near High Island and dumped 15 inches to

23.5 inches of rain on Jefferson, Orange and Newton counties in extreme Southeast Texas. Property damage estimated at \$11.6 million, primarily from flooding associated with the storm.

**Beulah** — Sept. 5-22, 1967: Southern Texas, Brownsville; 109 mph gust measured with damaged anemometer, 15 deaths. \$100 million to \$150 million in damage. Major floods in southern Texas, killing 10 people and causing most of the damage. Record number of tornadoes, 155, which killed five people.

**Celia** — July 23-Aug. 5, 1970: Corpus Christi; 162 mph wind gusts, 11 deaths, \$450 million to \$500 million damage; estimated insured loss: \$310 million. Greatest damage in west to east area where maximum gusts occurred.

**Fern** — Sept. 10, 1971: Moved inland near Matagorda; two dead, \$30.23 million damage, mostly from 10- to 26-inch rainfalls associated with the storm.

**Allen** — Aug. 10, 1980: Port Mansfield north of Brownsville; 129 mph gusts at Port Mansfield, 22 deaths, \$300 million damage. Twelve tornadoes were reported in Texas along with 10-15 inches rain. About half a million people evacuated along the Texas and Louisiana coast.

**Alicia** — Aug. 18, 1983: Moved inland near Galveston; 18 storm-related deaths, 135 mph wind gusts, damage estimated at \$1 billion, 12-foot tides in Galveston. Severe wind damage in downtown Houston. About 25,000 people evacuated the Houston-Galveston area. Six tornadoes associated with storm. ■

# TORNADO



Robert Mihovil

## TORNADO SAFETY RULES

There is no guaranteed safe place during a tornado, but some locations are better than others. Survival is possible by following suggested safety rules and using common sense.

### In A House

The safest place in a house is the innermost hallway on the lowest floor. Because the walls in a hallway are closely tied together, they will hold together better in high winds.

Avoid windows. Flying debris can kill—and the worst kind of flying debris is broken glass. Do not open windows. Time is too valuable and flying glass is dangerous.

Get under something strong, such as a workbench or heavy table, for added protection. If possible, cover your body with a blanket or sleeping bag. Protect your head with anything that is available.

Avoid concrete, rock or brick walls and chimneys. Rather than blowing over in high winds, they tend to collapse straight down.

An interior closet offers good protection. The closet has four walls closely tied together, and there are no windows. An interior bathroom is even better. Not only does it have four walls closely tied together, but the plumbing helps hold things together. The bathtub, sink and toilet also help support debris if the house collapses.

### Mobile Homes and Recreational Vehicles

During a tornado, one of the least desirable places to be is in a mobile home or recreational vehicle. Tornadoic winds can blow recreational vehicles over or knock mobile homes from foundations, rolling them along the ground and breaking them apart. If you are in a mobile home or recreational vehicle when a tornado approaches, seek other shelter immediately.

Seek shelter on foot if possible. Do not drive your car. Do not get under a mobile home or recreational vehicle.

### Motor Vehicles

As in the case of mobile homes and recreational vehicles, a motor vehicle is not the best place to be during a tornado. Cars, buses and trucks easily become flying missiles as a result of tornadoic winds.

Never try to outrun a tornado in your car. You'll lose.

Stop your vehicle and get out. Seek shelter some place else. Do not get under or next to your vehicle—it may roll over on you.

### Outdoors

If you are trapped outside and there is no building nearby, seek shelter in a ditch, gully, ravine or culvert. Even a low spot in the ground gives you some protection.

Do not seek shelter in a grove of trees. Remember to protect your head.

Remember—there is no guaranteed safe place during a tornado. Your best chance for survival is to get away from the killing winds. Do not stand up and watch the tornado. Seek shelter immediately. Your life and the lives of those around you may depend on your actions. Keeping alive during a tornado does not happen by chance.

## THUNDERSTORMS AND LIGHTNING

If you plan to be outdoors, check the latest weather forecast and keep an eye on the sky. At signs of an impending storm—towering thunderheads, darkening skies, lightning, increasing wind—listen to NOAA Weather Radio, or a local radio or television station for the latest information.

When a thunderstorm threatens, get inside your home, a large building or an all-metal (not convertible) automobile. Do not use electrical equipment (including hair dryers or electric shavers) while the storm is overhead. Do not use the telephone except for emergencies.

If you are caught outside, seek shelter in a low area under a thick growth of small trees. In open areas, go to a low place, such as a ditch. Do not stand under a tall, isolated tree or a utility pole.

If you are caught in a level, open field far from shelter and you feel your hair stand on end, lightning may be about to strike you.

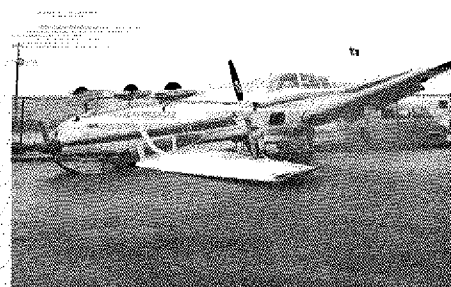
Drop to your knees and bend forward, putting your hands on your knees. Do not lie flat on the ground.

Get off or away from open water, metal farm or construction equipment, or small metal vehicles, such as motorcycles, bicycles or golf carts. Put your golf clubs down and take off your golf shoes (they have metal spikes). Stay away from open doors and windows, wire fences, clotheslines, and metal pipes and railings. If you are part of a group in the open, spread out, keeping people several yards apart.

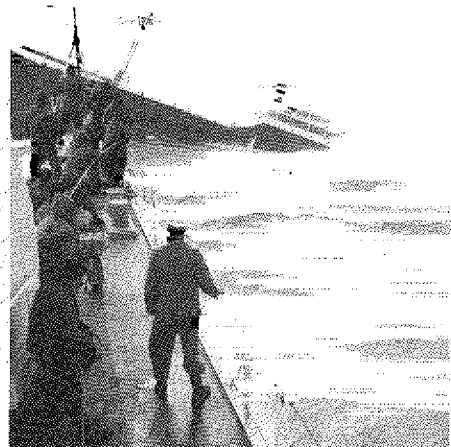
Remain calm. Thunderstorms usually last only a short time; even squall lines pass in a matter of a few hours. Be cautious—but do not be afraid. Stay indoors and keep informed. ■



Norman Martin



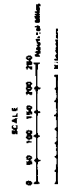
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U.S. Coast Guard

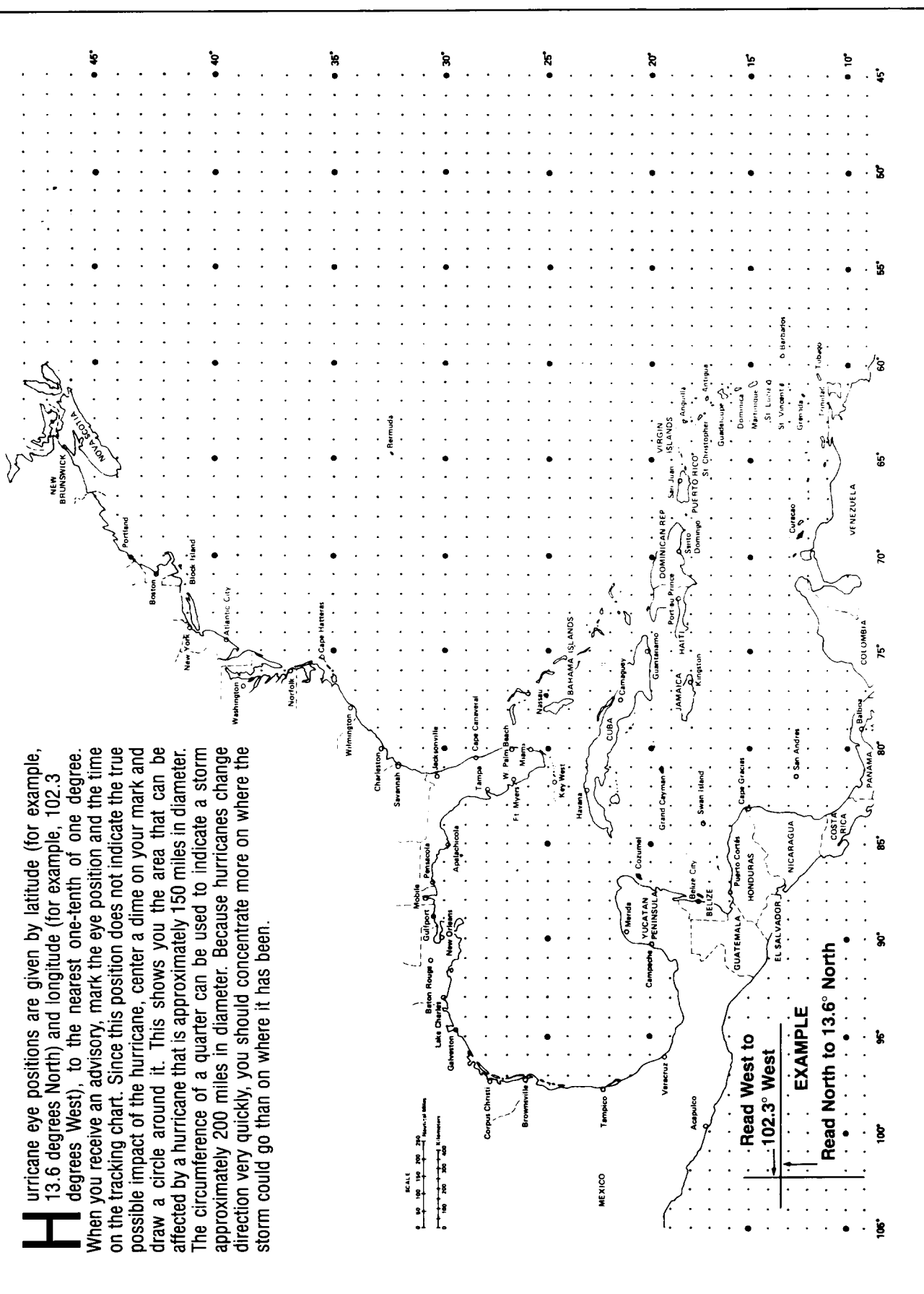
# TRACKING CHART

**H**urricane eye positions are given by latitude (for example, 13.6 degrees North) and longitude (for example, 102.3 degrees West), to the nearest one-tenth of one degree. When you receive an advisory, mark the eye position and the time on the tracking chart. Since this position does not indicate the true possible impact of the hurricane, center a dime on your mark and draw a circle around it. This shows you the area that can be affected by a hurricane that is approximately 150 miles in diameter. The circumference of a quarter can be used to indicate a storm approximately 200 miles in diameter. Because hurricanes change direction very quickly, you should concentrate more on where the storm could go than on where it has been.

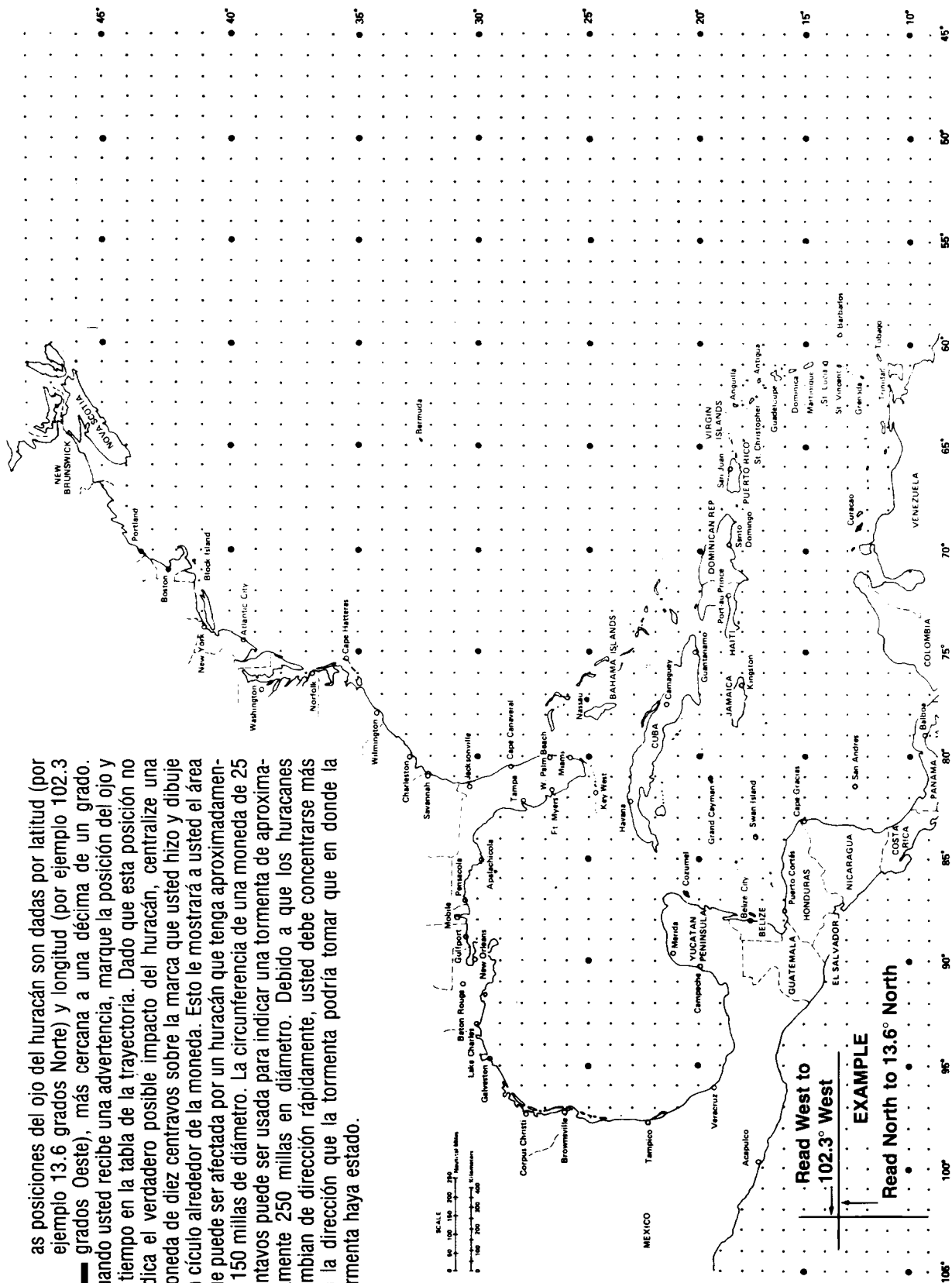


Read West to  
102.3° West

EXAMPLE  
Read North to 13.6° North



Las posiciones del ojo del huracán son dadas por latitud (por ejemplo 13.6 grados Norte) y longitud (por ejemplo 102.3 grados Oeste), más cercana a una décima de un grado. Cuando usted recibe una advertencia, marque la posición del ojo y el tiempo en la tabla de la trayectoria. Dado que esta posición no indica el verdadero posible impacto del huracán, centralice una moneda de diez centavos sobre la marca que usted hizo y dibuje un círculo alrededor de la moneda. Esto le mostrará a usted el área que puede ser afectada por un huracán que tenga aproximadamente 150 millas de diámetro. La circunferencia de una moneda de 25 centavos puede ser usada para indicar una tormenta de aproximadamente 250 millas en diámetro. Debido a que los huracanes cambian de dirección rápidamente, usted debe concentrarse más en la dirección que la tormenta podría tomar que en donde la tormenta haya estado.



# FLOW CHART

## EVACUATION GUIDELINES

---

**Am I at Risk?**

---

**NO** ↓

---

You are at risk, if:

- You live on the barrier or offshore islands.
- You live in a mobile home or recreational vehicle, even when threatened by a minimal hurricane.
- You live along a river, creek, saltwater canal or in a low-lying inland area.

---

**YES** ↓

---

**NO** ↓

---

**Have I been advised or ordered to evacuate by the governor or local elected officials through radio, TV or by an official representative of the community (law enforcement officers, fire officials)?**

---

**YES** →

---

**Prepare to evacuate using your own plan or the following decision checklist for evacuation planning. Go to decision checklist for evacuation planning.**

Stay home if your house is safe from potential flooding and able to withstand high winds. Stay tuned to local radio and TV for official advisories or bulletins from the National Weather Service.

---

**OR** →

---

---

**If in doubt or still concerned about your safety?**

---

- Evacuate outside the threatened area as far ahead of time as possible.
- Stay with friends or relatives or at a hotel/motel safe from potential flooding.
- Determine the best evacuation route to take.



# A DECISION GUIDE

---

**Do you have children?**

---

**NO** ↓

**YES** ←

---

- Special diet and baby foods
- Baby equipment (bedding, diapers, etc.) birth certificates
- Toys
- Hobby materials
- Reading and drawing supplies

---

**Do you have pets?**

---

**NO** ↓

**YES** ←

---

- Pets are not permitted at shelters
- Arrange accommodations at a kennel
- Or take necessary precautions at home

---

**Are you a homeowner or renter?**

---

**NO** ↓

**YES** ←

---

- Take important papers with you (insurance policies, property inventory, proof of residence)
- Turn off water supply
- Turn off air conditioner
- Disconnect all electrical appliances except food storage
- Shut off all gas appliances
- Lock all doors and windows

---

**Are you without a place to go?**

---

**NO** ↓

**YES** ←

---

- TV or radio broadcasts will inform you of designated emergency public shelters
- Bring:
  - Personal hygiene items (soap, toothbrush and paste, deodorants, first aid kit, aspirin, etc.)
  - Items necessary at shelter (water, bedding, non-perishable food, flashlight, batteries, portable AM/FM radio, etc.)
- Eat something before you leave home.

---

**Proceed to public shelter** ♦

---

---

**Are you, or is anyone in your family, ill or disabled?**

---

**NO** ↓

**YES** ←

---

- All prescription and other medicines
- Prosthetic devices
- Thermometer
- Emergency medical certification
- Eyeglasses
- Hearing aids
- Special diet foods
- Extra pillow and bedding

---

Proceed to planned destination.

---

# PUBLICATIONS

The following additional hurricane-related publications are available from the **Marine Information Service, Sea Grant College Program, Texas A&M University, College Station, Texas 77843**. Prices quoted are for single copies; write for prices for multiple copies. Request publication by both title and publication number, and send a check payable to Texas A&M University.

Emergency planners and government officials can order copies of the four evacuation studies listed below. Each provides data for decision making leading to regional coordination of evacuation before hurricanes. The data can also be used in specific county or city evacuation plans. Three methodologies are developed that can be used in other coastal areas as well. SLOSH (Sea, Lake, and Overland Surges from Hurricanes) is one such method.

**HURRICANE RELOCATION PLANNING FOR BRAZORIA, GALVESTON, HARRIS, FORT BEND AND CHAMBERS COUNTIES (TEXAS).**

Carlton Ruch. June 1981. 183 pages, 21 tables, 17 figures. \$5. *TAMU-SG-81-604*.

**HURRICANE RELOCATION PLANNING FOR ARANSAS, KENEDY, KLEBERG, NUECES, RUFUGIO AND SAN PATRICIO COUNTIES.**

Carlton Ruch. June 1983. 211 pages, 25 figures, 23 tables, 2 maps. \$5. *TAMU-SG-83-606*.

**HURRICANE RELOCATION PLANNING FOR HARDIN, JASPER, JEFFERSON, NEWTON AND ORANGE COUNTIES.**

Carlton Ruch. September 1983. 141 pages, 11 figures, 13 tables, 3 maps. \$5. *TAMU-SG-84-620*.

**HURRICANE RELOCATION PLANNING FOR CAMERON AND WILLACY COUNTIES.**

Carlton Ruch. September 1985. 155 pages, 11 tables, 8 figures, 2 maps. \$8. *TAMU-SG-86-601*.

**THE EFFECT OF SOCIAL INFLUENCE ON RESPONSE TO HURRICANE WARNINGS.**

Larry Christensen and Carlton E. Ruch. In *Disasters*, Vol. 42, No. 2, 1980. 8 pages, 10 figures, 3 tables. \$1. *TAMU-SG-81-809*. *NTIS—PB-81-199-895*.

**PROTECTING YOUR BOAT AGAINST SEVERE WEATHER.**

Dewayne Hollin and Ken Pagans. October 1984. 8 pages; 9 tables; 1 photograph. *TAMU-SG-84-511*.

The key to protecting boats from winter storms, hurricanes or any threatening weather is planning, preparation and timely action. This guide gives boatowners specific steps that they should follow, whether they plan to remove the boat from the storm area, secure it in the marina or take it to a hurricane hole. Included are diagrams of storm mooring techniques, an easy-to-read glossary of severe weather terms and tips on what to look for in a marina's severe weather



preparedness plan.

The following publications are available from the source indicated. Costs, if any, are also indicated.

**A WEEKEND IN SEPTEMBER.** John Edward Weems. College Station: Texas A&M University Press, 1980. 180 pages. \$10.95.

The weekend of Sept. 8, 1900, has been called the ultimate example of the terror and violence a hurricane can bring. The storm that swept Galveston Island that weekend killed more than 6,000 people and washed away two-thirds of the city's buildings.

Weems' account was written more than two decades ago when many survivors were still living and available for interviews. Weems recreates that fateful weekend as experienced by those who were actually there.

**STORMS, PEOPLE AND PROPERTY IN COASTAL NORTH CAROLINA.** Simon Baker. 82 pages, illustrated, Free. University of North Carolina Sea Grant Program, *UNC-SG-78-15*.

Baker recalls the destructive hurricanes and northeasters of the past, and discusses safety precautions and prevention of property damage.

**THE PREDICTION OF HURRICANE STORM SURGES.** D. Lee Harris. \$1. *Florida Sea Grant College Program, SGR-49*.

A state-of-the art survey, the purpose of this report is to encourage and assist non-meteorologists in making use of available technology. Although some of it is technical in nature, the non-specialist is able to gain an understanding of the problems involved in the prediction of coastal floods.

**HURRICANE MESSAGE ENHANCEMENT.** Carlton E. Ruch and Larry B. Christensen. January 1981. 140 pages, 43 figures, 18 tables. \$5. *TAMU-SG-80-202*. *NTIS—PB-81-243-677*.

Can people be stimulated to respond to hurricane information in ways that will maximize their safety? This report describes experiments conducted on Galveston Island to determine psychological responses in the subject areas of (1) Simulated hurricane variables; (2) Consequences of exposure to hurricane fury via television; (3) Influence of other residents, authority figures and events; (4) Response as a function of media presentation; (5) Response to fear, information and testimony in current hurricane material. Results are interpreted statistically and summarized in a hurricane response model. Recommendations are made.

**HURRICANE WATCH—HURRICANE WARNING—WHY DON'T PEOPLE LISTEN?** Carlton Ruch and Larry Christensen. May 1980. 4 pages. *TAMU-SG-80-508*.

In an effort to learn why some people respond to hurricane warnings while others do not, psychological experiments were conducted with residents of Galveston, Texas, an island 75 miles southeast of Houston that last experienced a major hurricane in 1961. The experiments were grouped into five subject areas: (1) simulated hurricane variables; (2) consequences of exposure to hurricane fury via television; (3) influence of other residents, authority figures and events; (4) response as a function of media presentation; and (5) response to fear, information and testimony in current hurricane material.

This Marine Advisory Bulletin summarizes the conclusions reached by the researchers. While some conclusions relate essentially to the uniqueness of Galveston, all are applicable to any coastal area which could experience a hurricane. The findings are particularly appropriate for those concerned with disaster or emergency planning and for members of the news media.

**HURRICANE-RESISTANT CONSTRUCTION FOR HOMES.** Todd L. Walton, Jr. 40 cents. (*MAP-16*), formerly *SUSF-SG-76-005*.

Discusses hurricane winds and the implication of probability concepts on home design in hazardous areas. Federal and local guidelines are reviewed including the National Flood Insurance Program, the Florida Coastal Construction Setback Line, and county building codes. ■

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We extend our most sincere appreciation to Dr. Aylmer Thompson, a professor in the Texas A&M University Department of Meteorology, for his assistance in preparation of this report. Our thanks also go to Dr. Neil Frank, director of the National Hurricane Center in Coral Gables, Fla. The hurricane flow chart evacuation guideline concept and information is adapted from a publication of the Lee County, Fla., Department of Public Safety, and is presented as a public service.

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