Standard Project Hurricane

Nancy J. Powell, PE
Chief, Hydrologic Engineering Section
New Orleans District

SPH

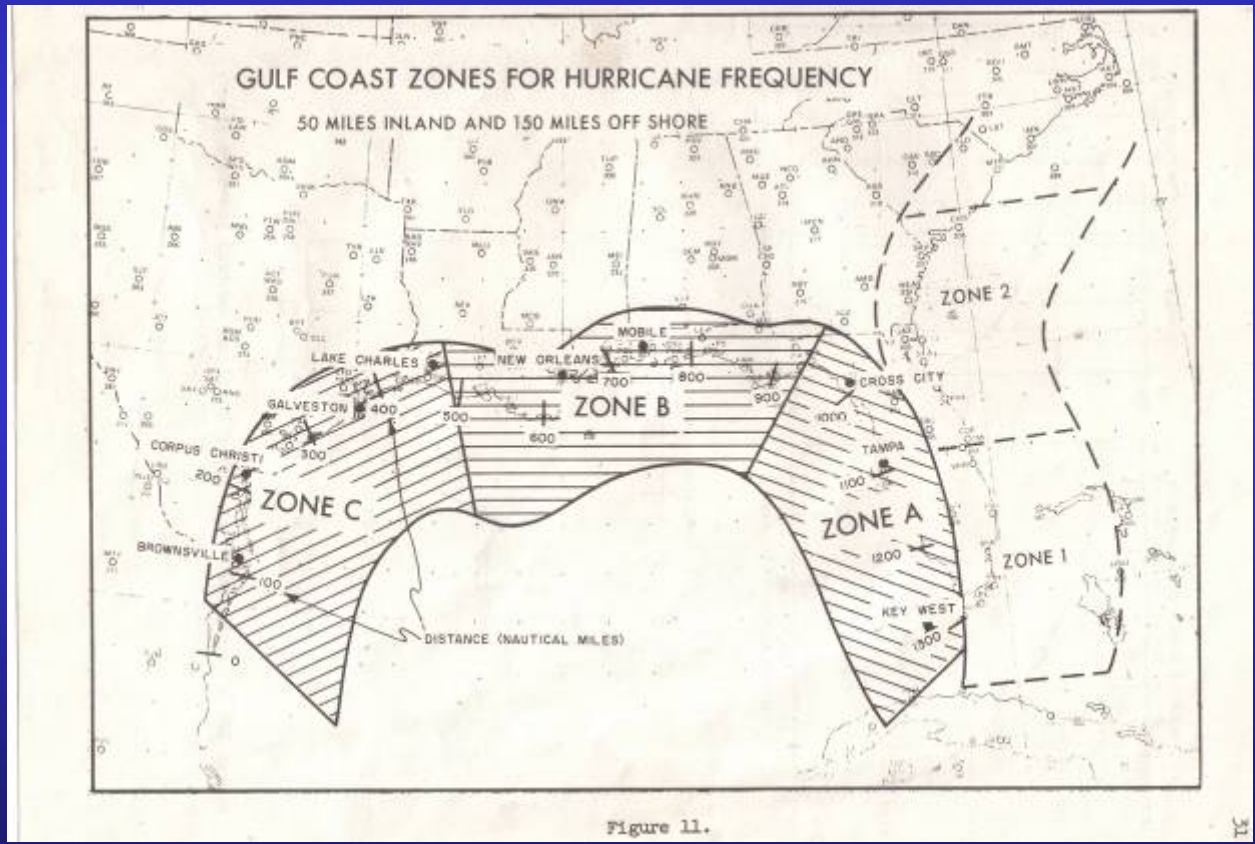
- Meteorological parameters for the SPH are contained in National Hurricane Research Project Report 33, “Meteorological Considerations Pertinent to Standard Project Hurricane, Atlantic and Gulf Coasts of the United States”, 1959.
- After Hurricane Betsy in 1965 the Weather Bureau revised the wind field parameters, but did not change the other characteristics of the SPH.

SPH

- Standard Project Hurricane (SPH) is defined as the most severe storm that is considered reasonably characteristic of a region.
- The SPH index is based on an analysis of past hurricanes of record. Hurricane characteristics are correlated with intensity criterion, location, and other features.
- The SPH hurricane is a steady state hurricane.

SPH

- Gulf Coast was divided into three zones.



SPH

- The central pressure index (CPI) is the principal intensity criterion for defining the SPH index.
- The CPI is the estimated minimum pressure for individual hurricanes in each zone.
- For any hurricanes, the CPI was determined from observations of minimum pressure at a given location; computations based on observational data; or by estimate in event that the hurricane passed through a zone where there were insufficient pressure observations to complete a computation but enough evidence to warrant an estimate.

SPH

- Period of Analysis – 1900 through 1956
- A list of storms for which the CPI was less than or equal to 29 inches was developed for each zone.
- In Zone B, 23 storms were identified with CPI < 29 inches.
- However, two storms, Audrey and Hilda, were not used in the frequency analysis; the parameters for these storms were not available at the time of SPH derivation.

SPH

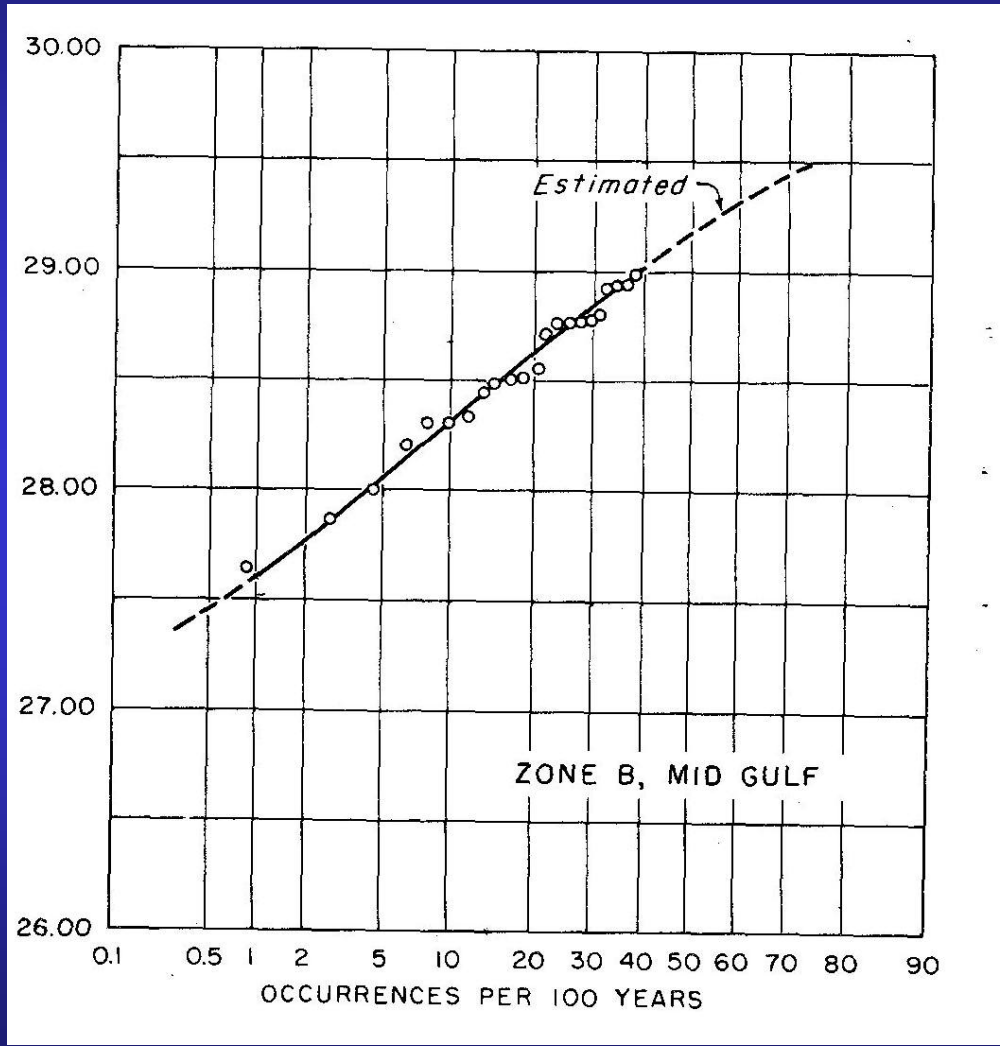
- A frequency analysis of CPI occurrences per 100 years was developed for each zone using the formula

$$P = \frac{100(M - 0.5)}{Y}$$

- *P* = percent chance of occurrence per year
- *M* = number of the event (rank)
- *Y* = the number of years of record (57)

US Army Corps of Engineers ®

SPH



SPH

- The radius to region of maximum winds (R) is an index of hurricane size and is an important factor in the generation of waves and tides.
- R was determined for the storms with CPI values less than 29 inches.
- R was determined from observations at a wind reporting station or by computations made from the pressure field.

$$P = \frac{100(M - 0.5)}{Y}$$

US Army Corps of Engineers ®

SPH

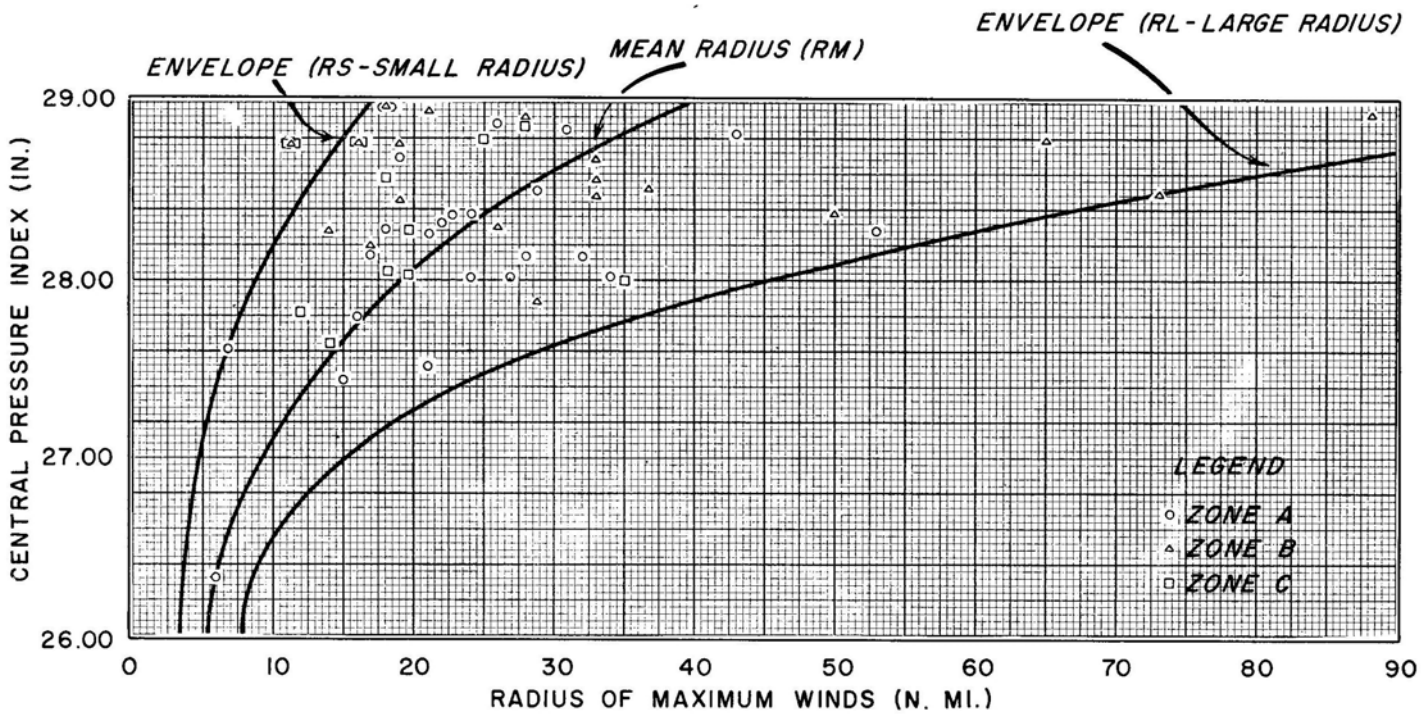


Figure 17. - Variation of radius of maximum winds with central pressure index, Gulf Coast, 1900-1956.

SPH

- The forward speed of translation of the hurricane centers is determined as the average speed for the period from 2 hours before to 2 hours after the hurricane enters the coast.
- Due to the limited latitudinal variation and limited data available, all of the Gulf coast hurricane forward speeds were used.

US Army Corps of Engineers ®

SPH

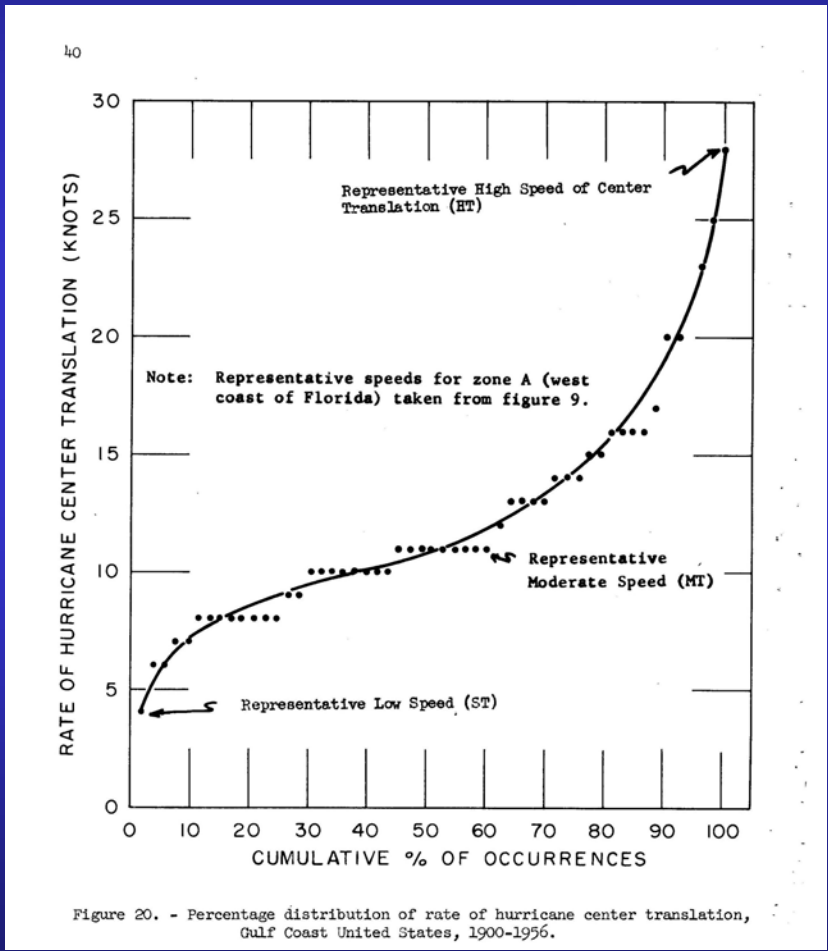


Figure 20. - Percentage distribution of rate of hurricane center translation, Gulf Coast United States, 1900-1956.

US Army Corps of Engineers ®

SPH

Central Pressure Index	CPI	27.60 inches
Peripheral Pressure	Pw	29.92 inches
Radius to Maximum Winds	Small R	7 N miles
	Moderate R	14 N miles
	Large R	30 N miles
Forward Speed	Slow T	4 knots
	Moderate T	11 knots
	High T	28 knots
Maximum 30 ft Wind Speed	Slow T	107 mph
	Moderate T	100 mph
	High T	111 mph

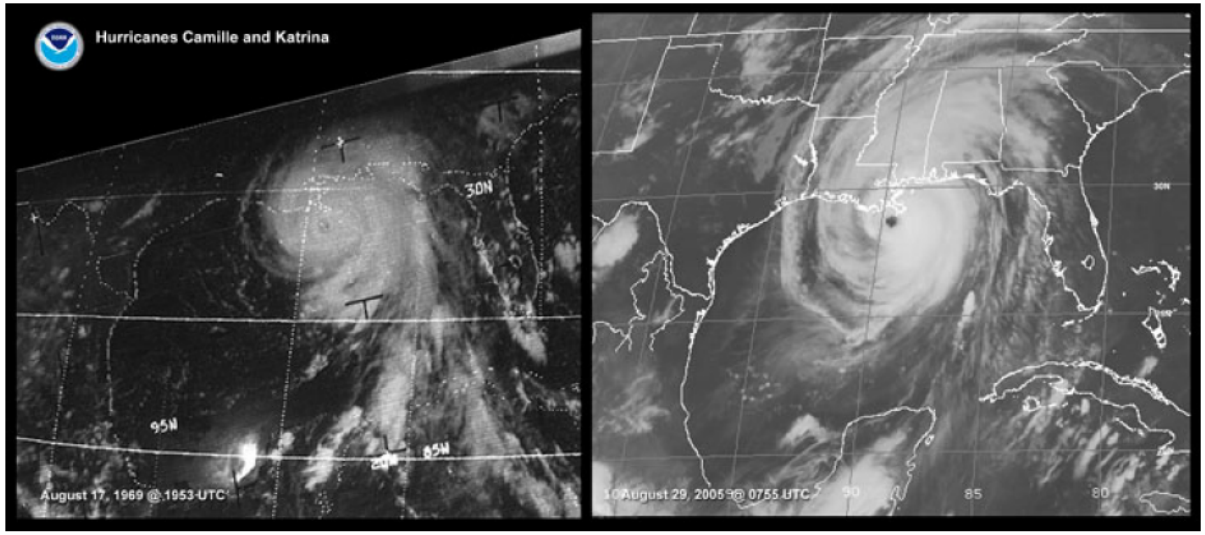
US Army Corps of Engineers ®

SPH vs Most Intense Hurricanes

Storm		Central Pressure at landfall
Camille	1969	909
Katrina	2005	920
Andrew	1992	922/956
1915 Storm	1915	931
SPH	theoretical	935
1947 Storm	1947	940
Rita	2005	937
Audrey	1957	945
Betsy	1965	948

US Army Corps of Engineers ®

SPH vs Katrina



	SPH	Katrina
Wind speed	101 mph	127 mph
Central pressure	27.60 inches	27.17 inches
Radius max winds	30 N miles	25 to 30 N miles
Forward speed	15 mph	15 mph

SPH

- Design elevation
  - Stillwater or wind tide level
  - Runup height from waves, if present
  - Freeboard
- Stillwater elevation
  - Tide
  - Pressure setup
  - Setup due to winds
  - Buildup

SPH

- Setup due to winds computed using a general wind tide equation

$$S = 1.165x10^{-3} \frac{V^2 F}{D} NZ \cos\theta$$

- *S* = wind setup in feet
- *V* = windspeed in statute miles per hour
- *F* = fetch length in statute miles
- *D* = average depth of fetch in feet
- *Θ* = angle between direction of wind and the fetch
- *N* = planform factor, generally equal to unity
- *Z* = surge adjustment factor

SPH

- Two historical storms along the Mississippi coast, the September 1915 and September 1947 hurricanes, were used to establish and verify procedure.
- The computed maximum surge height was compared to the observed high water marks from these storms.
- *Z* , surge adjustment factor, was computed so that computed maximum surge height agreed with observed high water marks.

SPH

- Procedure was applied to Louisiana coast.
- Chalmette Loop levee reach.
- Three storms, September 1915, September 1947, and September 1956, were used to compute Z, surge adjustment factors, for four locations.
- Setup due to winds was computed.
- Maximum surge elevation was computed.

SPH

- Wave runup calculations were made using model study data developed by Saville and presented in CERC Technical Report 4.
- For the Chalmette Loop
  - Average depth of fetch = 9.7 to 16.3 ft
  - Significant wave height = 4.6 to 7.0 ft
  - Wave period = 5.2 to 6.4 ft
  - Wave runup height = 4.3 to 4.7 ft

SPH

- Design elevation, Chalmette Loop
  - IHNC to Paris Road
    - Maximum Surge Elevation = 13.0 ft MSL
    - No wave runup
    - Freeboard = 1 ft
    - Design Elevation = 14.0 ft MSL
  - Paris Road to Bayou Lawler (MRGO reach)
    - Maximum Surge Elevation = 12.5 – 13.0 ft MSL
    - Wave Runup Height = 4.3 to 4.7 ft
    - Design Elevation = 17.5 MSL

SPH

- For the Chalmette Extension, the presence of coastal wetlands was considered in the development of the maximum surge elevation at the location of the protection system.
  - Maximum surge height would occur near the coastline.
  - The surge height would decrease inland.
- From a study of high water marks at the coastline and inland, a simple relationship between maximum surge height and distance inland was developed.
- A weighted mean decrease in surge height of 1 ft per 2.75 miles was determined.

SPH

- For the three interior drainage canals in Orleans Parish, step backwater calculations were made using HEC-2 to compute maximum water surface elevations during the SPH event.
- Starting water surface elevation in Lake Pontchartrain = 11.5 ft NGVD (maximum wind tide elevation in the lake at that location)
- Future work, such as floodproofing, raising bridges, and additional pump capacity, was considered in the analysis.
- No wave runup.
- 2 ft of freeboard was added.

Standard Project Hurricane

Nancy J. Powell, PE
Chief, Hydrologic Engineering Section
New Orleans District