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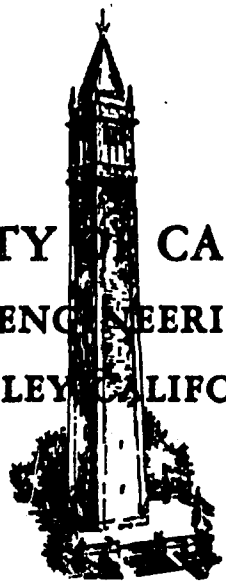

UNIVERSITY OF CALIFORNIA
INSTITUTE OF ENGINEERING RESEARCH
BERKELEY CALIFORNIA

Summary of

Wave Data for San Francisco Bay and Vicinity

By

J. W. Johnson

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Waves Research Laboratory
Technical Report
Series 3, Issue 349

Summary of Wave Data for San Francisco Bay and Vicinity

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J. W. Johnson

Berkeley, California

February 1953

Summary of

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Introduction: Considerable information is available on wave conditions both inside and outside of San Francisco Bay. Although these data were obtained either by visual observation or by the hindcasting technique, and consequently are relatively crude compared with data obtained by recording wave gages, the information is the best available and probably correct as to general order of magnitude and frequency of occurrence. The locations at which observations have been made are shown on Figure 1. The type of information, method of observation, location, and the length of time for which data are available are summarized below.

Wave Conditions in San Francisco and San Pablo Bays: Locations where wave heights, wave direction, sea state, and frequency of occurrence have been observed are summarized for the following localities:

1. Carquinez Straits
2. East Brothers Island
3. Alcatraz Island
4. Hunters Point

The observations at the first three of these localities were obtained visually by Coast Guard personnel and are summarized in Figures 2-6, inclusive. Figure 2 gives the percent of time that the sea state (wave heights) at Carquinez Straits existed as obtained from 1½ years of observation. Figure 3 shows a similar plot for East Brothers Island as observed for the same period of time. Figure 4 shows the frequency with which waves approached East Brothers Island from various directions. From the very nature of the location of this island wave heights of appreciable magnitude can exist only from a northerly or a southerly direction. The fetch is too limited to permit the generation of waves of an appreciable height from any other direction. Plots of sea state and frequency of wave directions are shown in Figures 5 and 6, respectively, for Alcatraz Island. Because of location and prevailing winds, waves approach Alcatraz Island predominantly from due west.

The only other known data on wave conditions within San Francisco Bay was compiled for Hunters Point by the hindcasting technique from observed wind records. This study was made in connection with a proposed breakwater for Hunters Point (1).** Figure 7 shows a "wave rose" compiled from wind observations obtained at U. S. Weather Bureau Stations over the 16 year period from 1930 to 1946. The procedure followed in this analysis is described elsewhere (2). Because of the fetch and wind conditions, high waves can occur from either the North to North North East or from the South to Southeast. The prevailing winds at Hunters Point are from the west, but no fetch exists in which waves of appreciable height can be generated.

Wave Conditions Outside San Francisco Bay: As in the case of wave observations within the Bay, wave data have been compiled both by visual observation and by the hindcasting technique. In addition to the location of wave observation stations shown in Figure 1, wave roses have been prepared for a location offshore in deep water (at 37.5°N, long. 123.0°W.) by hindcasting from weather

*The data presented herein were compiled on a University sponsored research project. Because of the general interest in this subject these data are summarized as a project report on this contract.

**See references.

maps for the three year period, 1936-1938, inclusive (3). These data are summarized in the form of wave roses in Figure 8. The diagrams in this figure show the percent of time that waves of various heights occur during three periods throughout the year - the summer period, the winter period, and a "transition" period. These wave roses show definitely that the prevailing wave direction on this portion of the coast is from the northwest.

Other offshore wave data have been obtained at the San Francisco Light Ship. These data were obtained by visual observation every six hours (0430 PST, 1030 PST, 1630 PST, and 2230 PST) and transmitted to the U.S. Weather Bureau in San Francisco where the wave height, period, and direction is entered in code on the weather charts issued for each of these 6 hour periods. The weather charts for the three year period from Sept. 1, 1949 through Aug. 31, 1952 have been procured and the wave data summarized into the wave roses shown in Figures 9-20. These figures show the percent of time that various wave heights and periods occurred during the various months of the year as averaged from the three years of record. As to be expected from an examination of Figure 8, the greater percentage of the highest waves at the entrance to the Golden Gate approach from West and from the Northwest.

Of interest in giving information on how the waves in deep water might transform in approaching the shore is the refraction diagram presented in Figure 24. This diagram was prepared by the San Francisco District, Corps of Engineers, in connection with an investigation of proposed small-craft harbors. This diagram covers the approaches to San Francisco Bay for an 8 second period wave approaching the coast line from the Northwest. A summary of other diagrams prepared for this area is presented in Table I.

In addition to the offshore wave data, visual observations have been made at Point Bonita and Point Montara (See Figure 1 for location) for the 1½ year period from January 1951 to July 1952. A summary of the Point Bonita data is presented in Figures 21 and 22. Figure 21 shows the state of the sea by months, whereas Figure 22 shows the state of the sea for various directions. A plot similar to Figure 21 is shown in Figure 23 where the state of the sea at Point Montara is presented for various months.

Table I - Refraction Diagrams for the Central California Coast

Location	Wave Pd.	Wave Direction	Scale	Date
Pt. Reyes to Santa Cruz	8	NW	1:210000	no date
Golden Gate, North to Fort Ross	8	W	1:210000	no date
"	8	SW	1:210668	no date
"	12	WNW	not given	9-26-50
"	12	W	1:210000	no date
"	12	SW	1:210000	4-21-50
"	16	NW	not given	8-50
"	16	WNW	not given	9-18-50
"	16	W	1:210000	no date
"	16	SW	not given	4-18-50

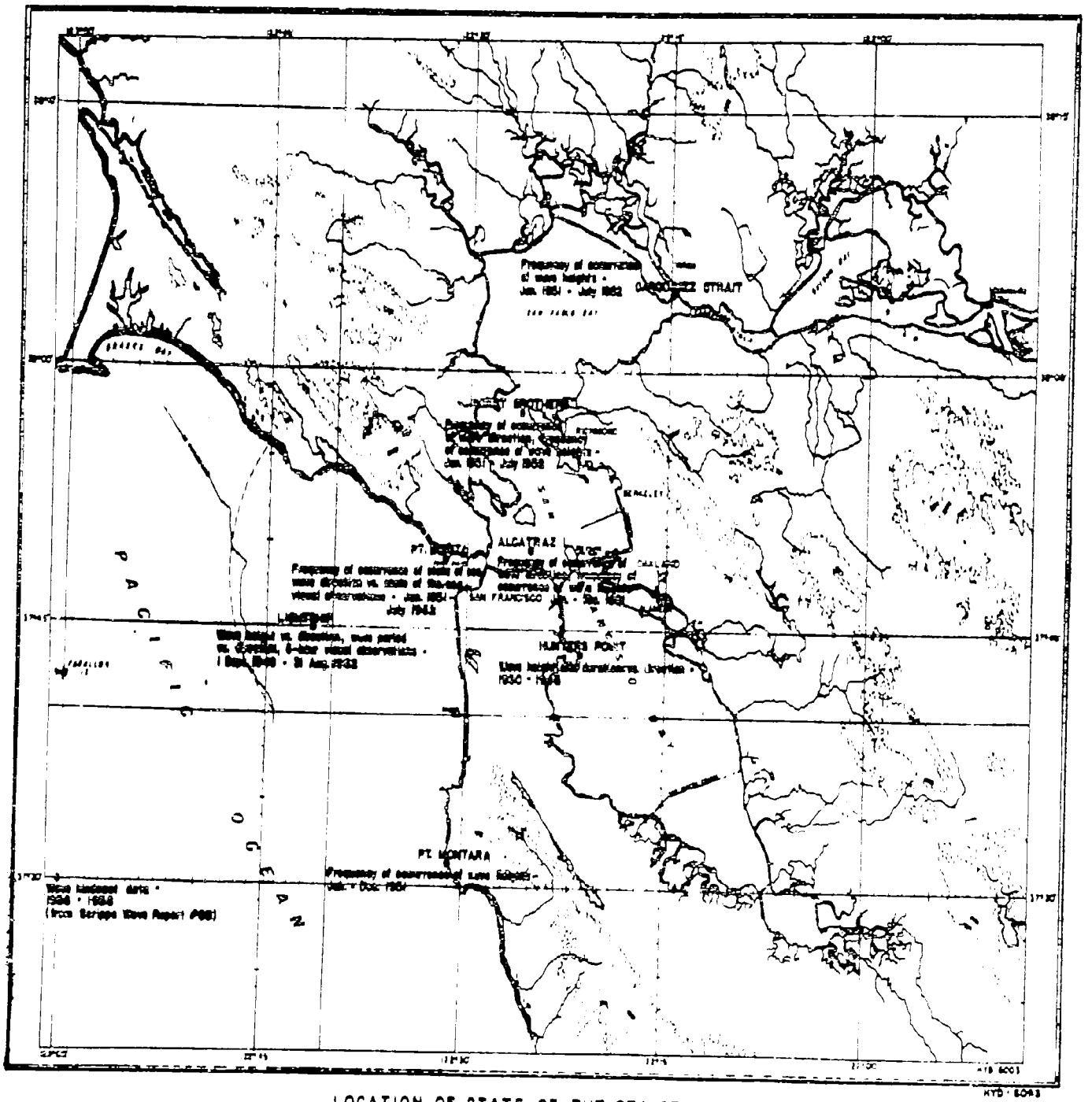
Summary: Although these various data, particularly the visual observations, are only estimates and of course subject to considerable error, it is believed that the information is sufficiently accurate to indicate general orders of magnitude - both as to wave height and to frequency of occurrence. Certainly the data, crude as they are, are much more complete than can be found for any other location of similar importance.

References:

(1) Putnam, J. A., and K. J. Bermel. Interim report No. 2: Breakwater model studies, U.S. Navy Drydocks, Hunters Point, Calif. Technical Report 140-2, Institute of Engineering Research, Univ. of Calif. 1946.

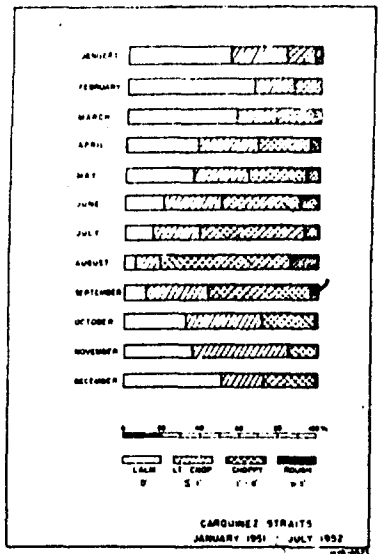
(2) Putnam, J.A., Estimating storm-wave conditions in San Francisco Bay, Trans. Amer. Geo. Union, vol. 28, no. 2, April 1947.

(3) Scripps Institution of Oceanography, A statistical study of wave conditions of five open sea localities along the California coast. S.I.O. Wave Report, No. 68, July 1947.



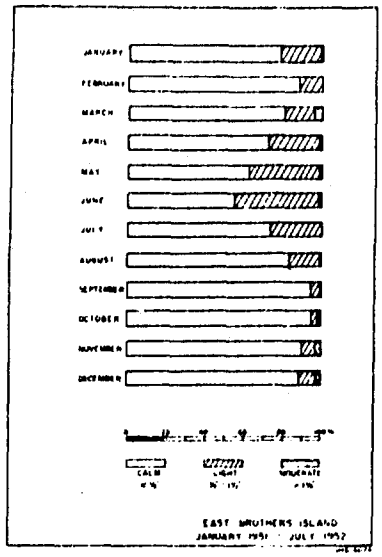
LOCATION OF STATE OF THE SEA STATIONS

FIGURE 1



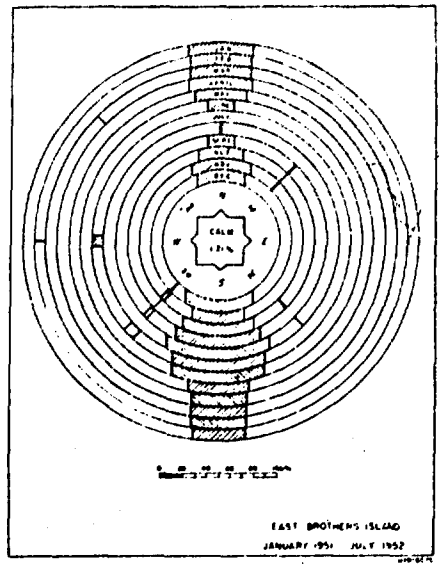
PERCENT OF TIME WAVE HEIGHTS
OF VARIOUS MAGNITUDE OCCURRED

FIG. 2



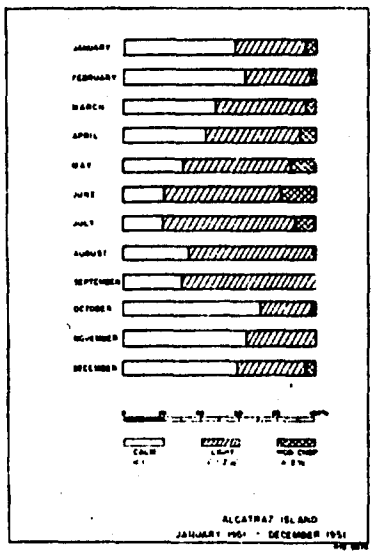
PERCENT OF TIME WAVE HEIGHTS
OF VARIOUS MAGNITUDE OCCURRED

FIG. 3



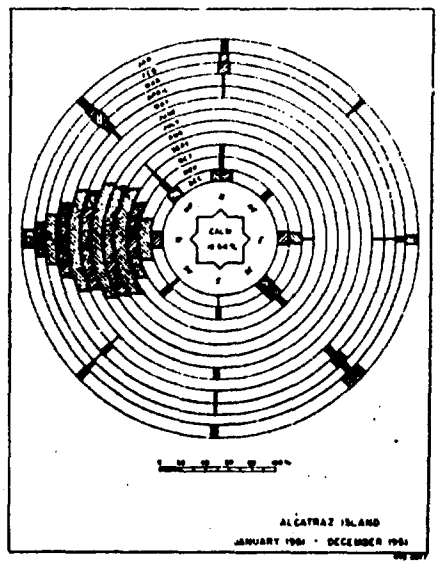
FREQUENCY OF OCCURRENCE OF WAVE ACTION
FROM VARIOUS DIRECTIONS

FIG. 4



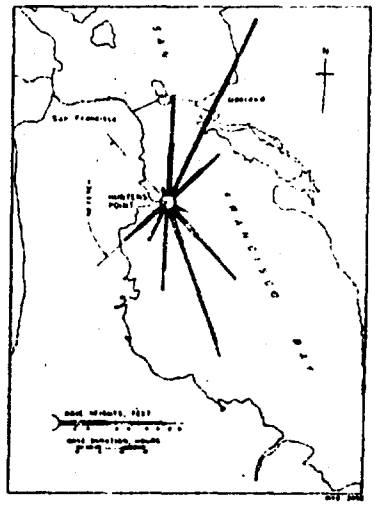
PERCENT OF TIME WAVE HEIGHTS
OF VARIOUS MAGNITUDE OCCURRED

FIG. 5

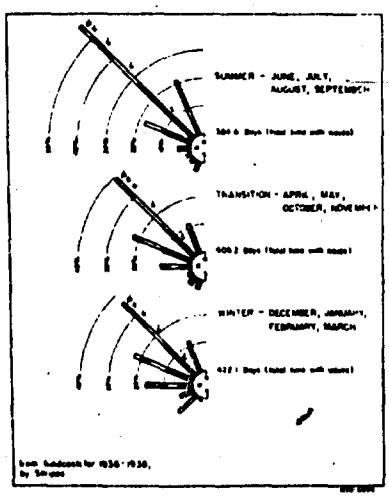


FREQUENCY OF OCCURRENCE OF WAVE ACTION
FROM VARIOUS DIRECTIONS

FIG. 6

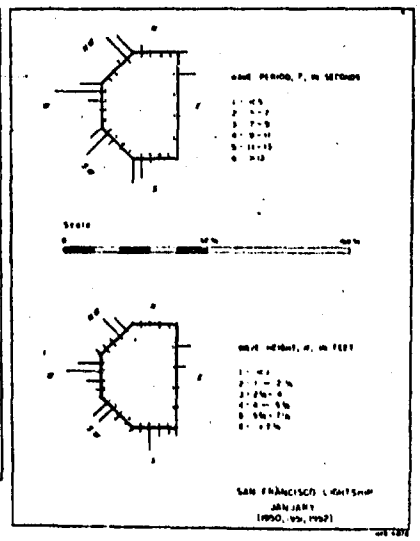


WAVE ROSE FOR HUNTERS POINT
BASED ON WIND DATA FOR PERIOD 1930 TO 1946



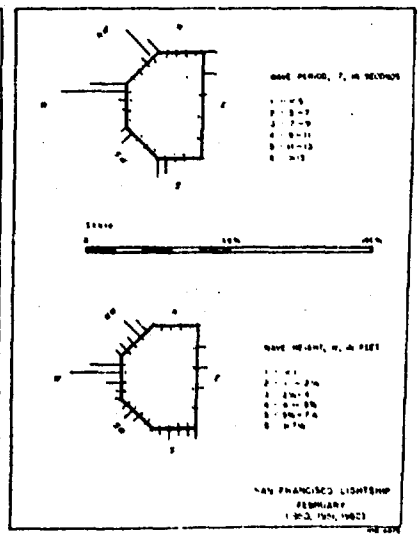
WAVE ROSES, VICINITY SAN FRANCISCO LIGHTSHIP

FIG. 8



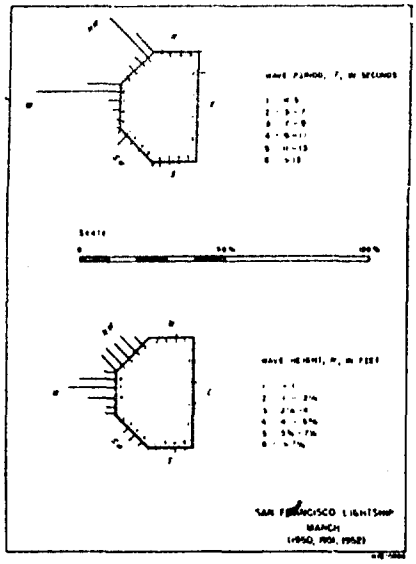
PERCENT OF TIME WAVE HEIGHTS AND WAVE PERIODS
OF VARIOUS MAGNITUDE OCCURRED FROM VARIOUS DIRECTIONS

FIG. 9



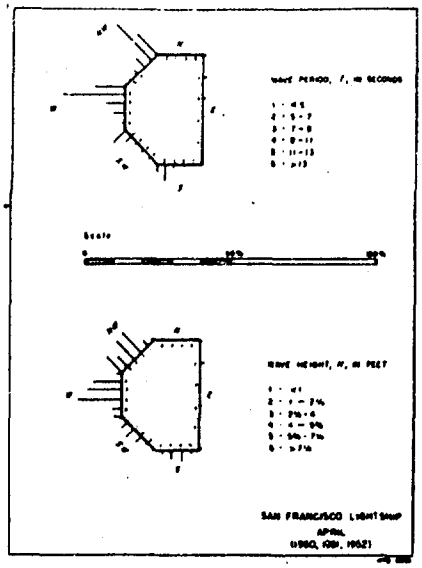
PERCENT OF TIME WAVE HEIGHTS AND WAVE PERIODS
OF VARIOUS MAGNITUDE OCCURRED FROM VARIOUS DIRECTIONS

FIG. 10



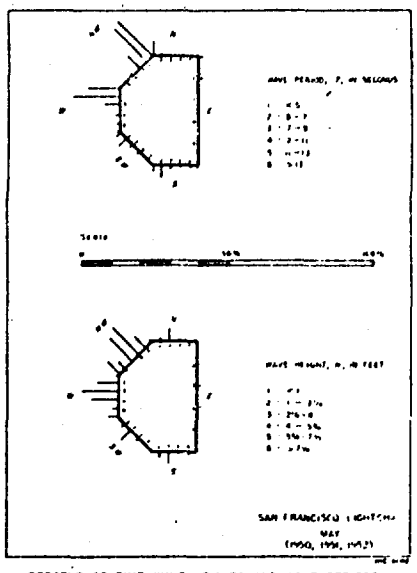
PERCENT OF TIME WAVE HEIGHTS AND WAVE PERIODS OF VARIOUS MAGNITUDE OCCURRED FROM VARIOUS DIRECTIONS

FIG. 11



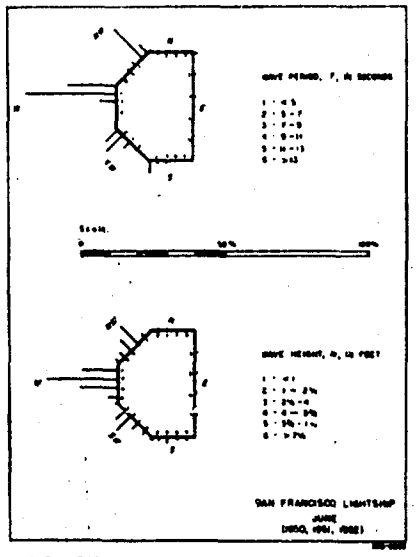
PERCENT OF TIME WAVE HEIGHTS AND WAVE PERIODS OF VARIOUS MAGNITUDE OCCURRED FROM VARIOUS DIRECTIONS

FIG. 12



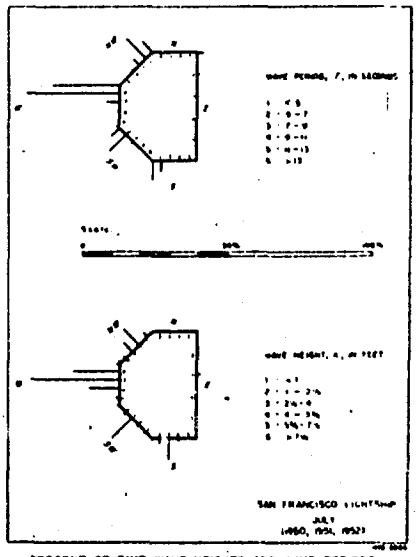
PERCENT OF TIME WAVE HEIGHTS AND WAVE PERIODS OF VARIOUS MAGNITUDE OCCURRED FROM VARIOUS DIRECTIONS

FIG. 13



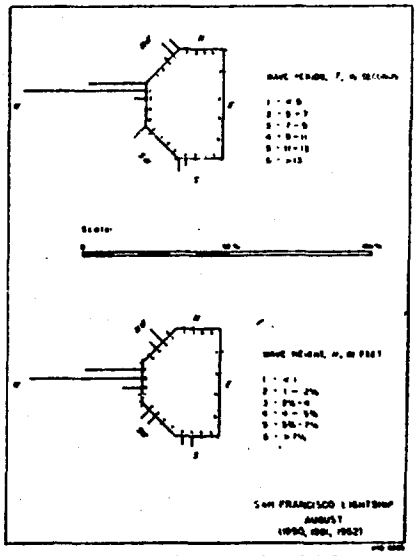
PERCENT OF TIME WAVE HEIGHTS AND WAVE PERIODS OF VARIOUS MAGNITUDE OCCURRED FROM VARIOUS DIRECTIONS

FIG. 14



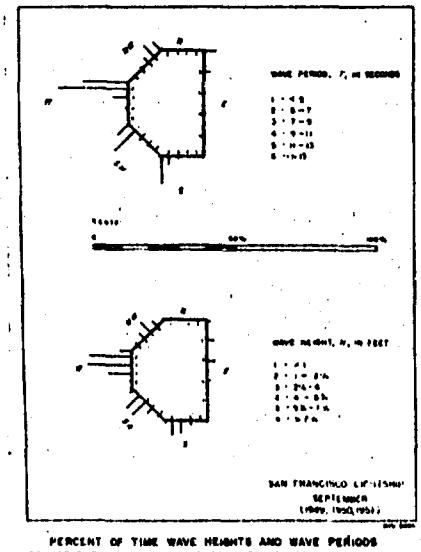
PERCENT OF TIME WAVE HEIGHTS AND WAVE PERIODS OF VARIOUS MAGNITUDE OCCURRED FROM VARIOUS DIRECTIONS

FIG. 15



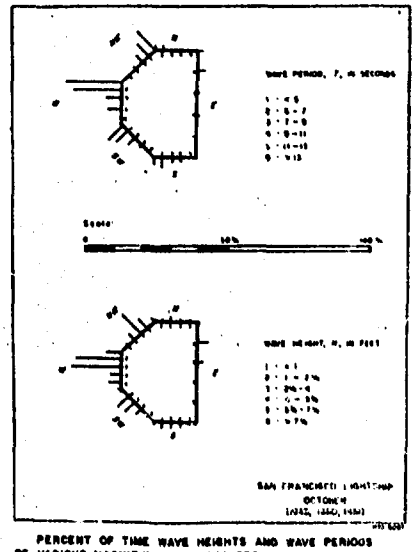
PERCENT OF TIME WAVE HEIGHTS AND WAVE PERIODS OF VARIOUS MAGNITUDE OCCURRED FROM VARIOUS DIRECTIONS

FIG. 16



PERCENT OF TIME WAVE HEIGHTS AND WAVE PERIODS OF VARIOUS MAGNITUDE OCCURRED FROM VARIOUS DIRECTIONS

FIG. 17



PERCENT OF TIME WAVE HEIGHTS AND WAVE PERIODS OF VARIOUS MAGNITUDE OCCURRED FROM VARIOUS DIRECTIONS

FIG. 18

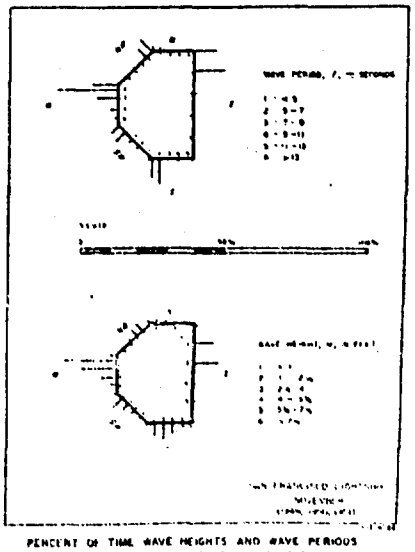


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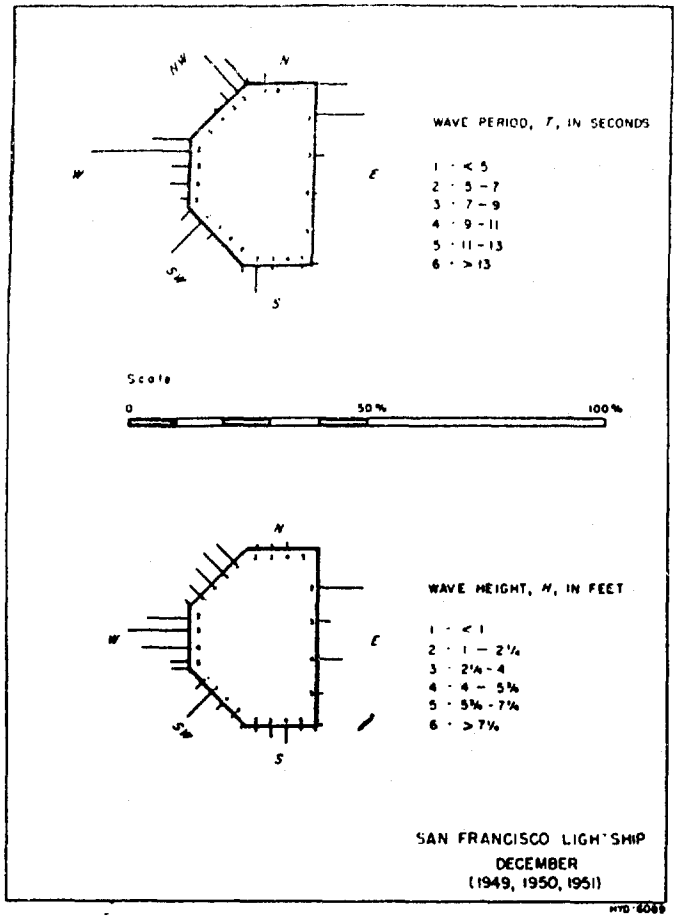
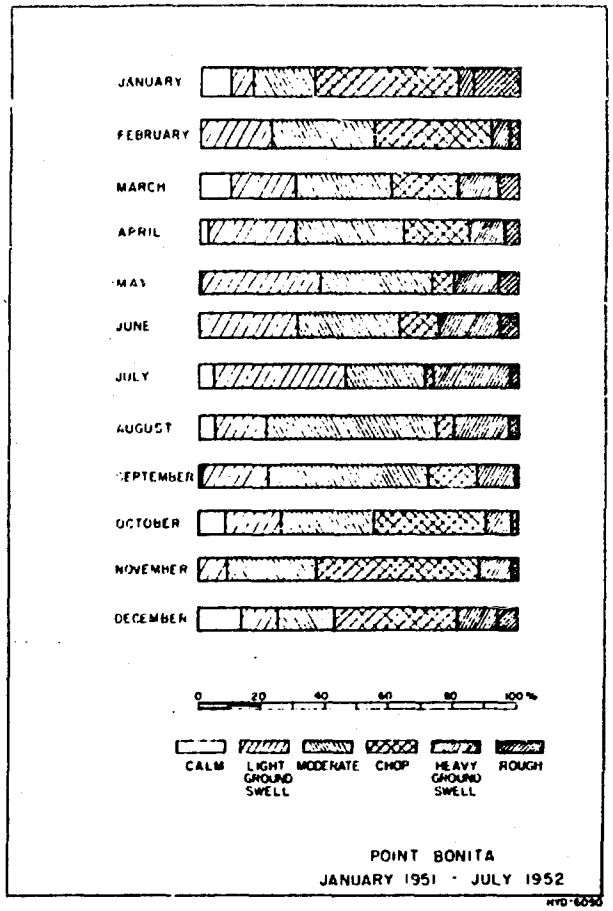
FIG. 19



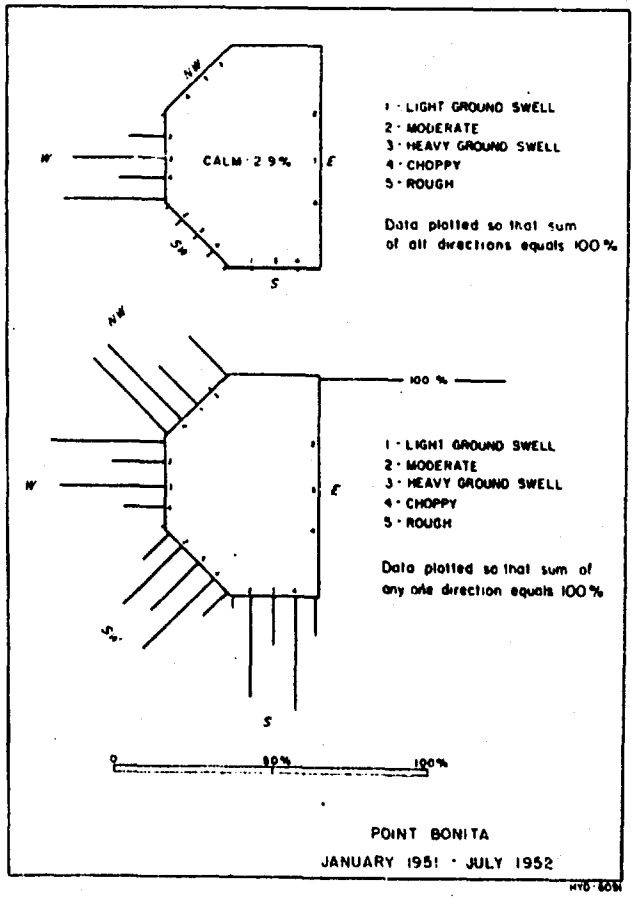
PERCENT OF TIME WAVE HEIGHTS AND WAVE PERIODS OF VARIOUS MAGNITUDE OCCURRED FROM VARIOUS DIRECTIONS

FIG. 20



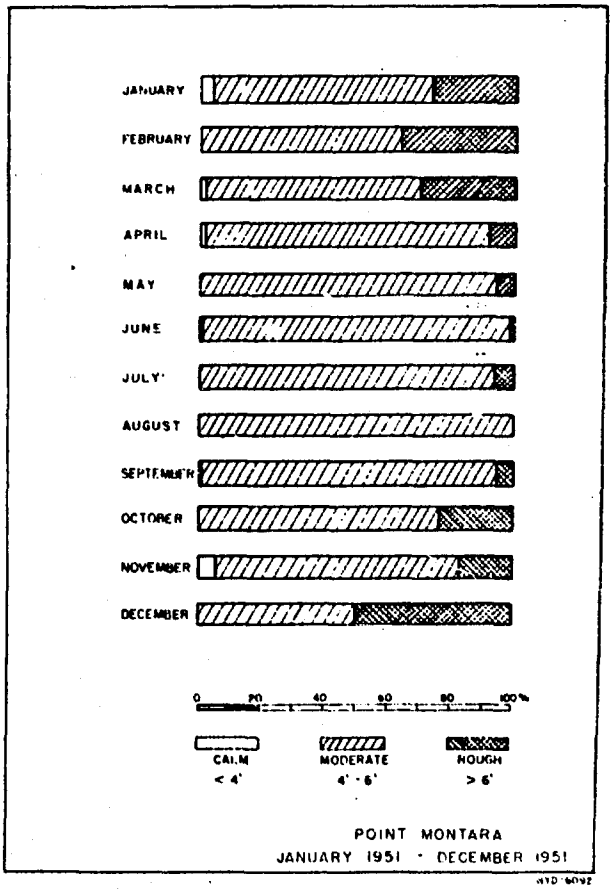
PERCENT OF TIME WAVE HEIGHTS OF VARIOUS MAGNITUDE OCCURRED

FIG. 21



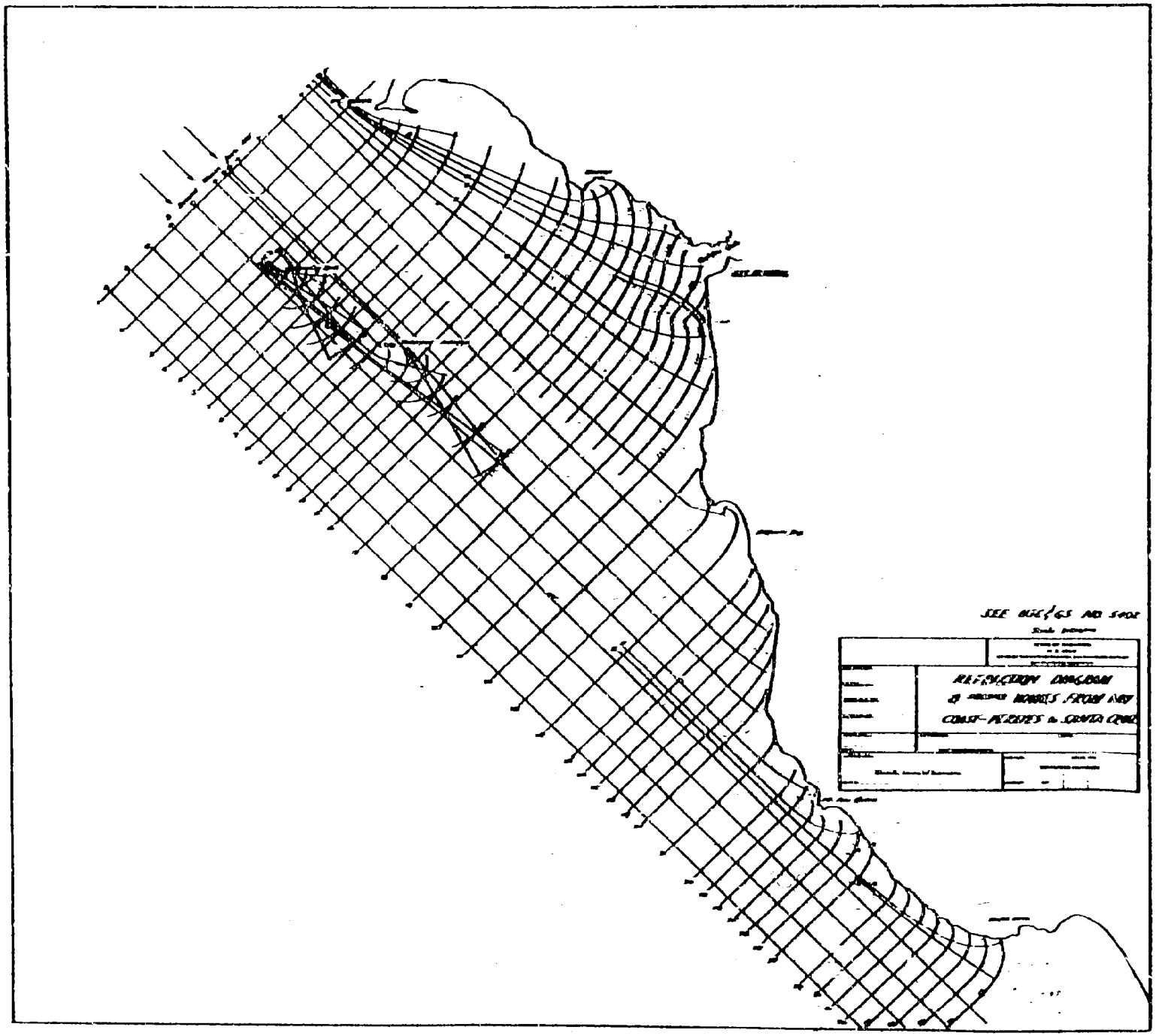
PERCENT OF TIME WAVES OF VARIOUS MAGNITUDE OCCURRED FROM VARIOUS DIRECTIONS

FIG. 22



PERCENT OF TIME WAVE HEIGHTS OF VARIOUS MAGNITUDE OCCURRED

FIG. 23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