Instrumentation at CERC's Field Research Facility, Duck, North Carolina

by
H. Carl Miller

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Report describes the oceanographic and meteorological instrumentation used for the collection of environmental data at the Coastal Engineering Research Center's (CERC) Field Research Facility (FRF) at Duck, North Carolina; the necessary information for proper interpretation of the instrument data is also presented. An appendix contains installation summaries for each instrument described in the report.

PREFACE

This report provides a basic description of the oceanographic and meteorological instrumentation used for the collection of environmental data at the Coastal Engineering Research Center's (CERC) Field Research Facility (FRF) at Duck, North Carolina; it also provides the information necessary for proper interpretation of the instrument data. The report is intended as a reference for subsequent reports which will contain summaries of the data collected from the instruments. The work was carried out under the CERC's waves and coastal flooding program.

The report was prepared by H. Carl Miller, Oceanographer, under the supervision of Dr. C.L. Vincent, Chief, Coastal Oceanography Branch and C. Mason, Chief, Field Research Facility Group, Research Division.

The author acknowledges the helpful review comments from M.G. Mattie of CERC, R. Masterson, National Ocean Survey (NOS), and J. O'Brien, National Weather Service (NWS), National Oceanic and Atmospheric Administration (NOAA).

Comments on this publication are invited.

Approved for publication in accordance with Public Law 166, 79th Congress, approved 31 July 1945, as supplemented by Public Law 172, 88th Congress, approved 7 November 1963.

TED E. BISHOP
Colonel, Corps of Engineers
Commander and Director

CONTENTS

FIGURES

CONTENTS

FIGURES--Continued

CONVERSION FACTORS, U.S. CUSTOMARY TO METRIC (SI) UNITS OF MEASUREMENT

U.S. customary units of measurement used in this report can be converted to metric (SI) units as follows:

Multiply	by	To obtain
inches	25.4	millimeters
	2.54	centimeters
square inches	6.452	square centimeters
cubic inches	16.39	cubic centimeters
feet	30.48	centimeters
	0.3048	meters
square feet	0.0929	square meters
cubic feet	0.0283	cubic meters
yards	0.9144	meters
square yards	0.836	square meters
cubic yards	0.7646	cubic meters
miles	1.6093	kilometers
square miles	259.0	hectares
knots	1.852	kilometers per hour
acres	0.4047	hectares
foot-pounds	1.3558	newton meters
millibars	1.0197×10^{-3}	kilograms per square centimeter
ounces	28.35	grams
pounds	453.6	grams
	0.4536	kilograms
ton, long	1.0160	metric tons
ton, short	0.9072	metric tons
degrees (angle)	0.01745	radians
Fahrenheit degrees	5/9	Celsius degrees or Kelvins[1]

[1]To obtain Celsius (C) temperature readings from Fahrenheit (F) readings, use formula: C = (5/9) (F -32).

To obtain Kelvin (K) readings, use formula: K = (5/9) (F -32) + 273.15.

INSTRUMENTATION AT CERC'S FIELD RESEARCH FACILITY, DUCK, NORTH CAROLINA

by
H. Carl Miller

I. INTRODUCTION

The Coastal Engineering Research Center's (CERC) Field Research Facility (FRF) is located on the Outer Banks, North Carolina, near the village of Duck (Fig. 1). The FRF provides a means for obtaining high-quality field data, particularly during storms, in support of the U.S. Army Corps of Engineers coastal research missions. The FRF consists of an 1,840 foot-long concrete research pier supported on 3-foot-diameter steel piles. The pier deck is 20 feet wide, 25 feet above mean sea level (MSL), and extends from behind the dunes to approximately the 25-foot depth contour. In addition, the main building contains offices, a technical library, an instrument repair shop, and a data acquisition room.

A Basic Environmental Measurements (BEM) program has been established to collect, analyze, and disseminate data on selected oceanographic and meteorological conditions at the FRF. Weekly bottom profiles along both sides of the pier and periodic bathymetric surveys (from behind the dune to 1 or 2 miles from shore) along ranges as far as 2.5 miles north and south of the pier are also performed as part of the BEM.

This report describes the instrumentation maintained at the FRF for the BEM study and the types of data that are obtained as part of that program. It is intended as a reference report to provide users with information necessary for an understanding of how and where the data are collected. Subsequent reports will summarize the data collected by the instruments described herein.

Section II describes the instruments and their locations. Section III describes the data sampling procedure and the format of each type of data summary; Section IV discusses how to request data from CERC. An Appendix contains installation summaries for each instrument described in this report.

II. INSTRUMENTATION AT THE FRF

CERC maintains most of the oceanographic and meteorologic instrumentation in the vicinity of the FRF. However, tide gages have been installed by the National Ocean Survey (NOS), National Oceanic and Atmospheric Administration (NOAA) to monitor water levels in the ocean along the pier and in the sound adjacent to the FRF. The NOS Tides Branch at Rockville, Maryland, prepares monthly water level summaries from selected gages. In addition, the National Weather Service (NWS), NOAA, maintains wind measuring anemometers at the facility.

1. Oceanographic Instruments.

The location of each oceanographic instrument at the FRF (described below) is shown in Figure 2; station numbers in the figure correspond to the distance (in feet) from a reference base line to the installation. The shore end of the pier is at station number 1+20.

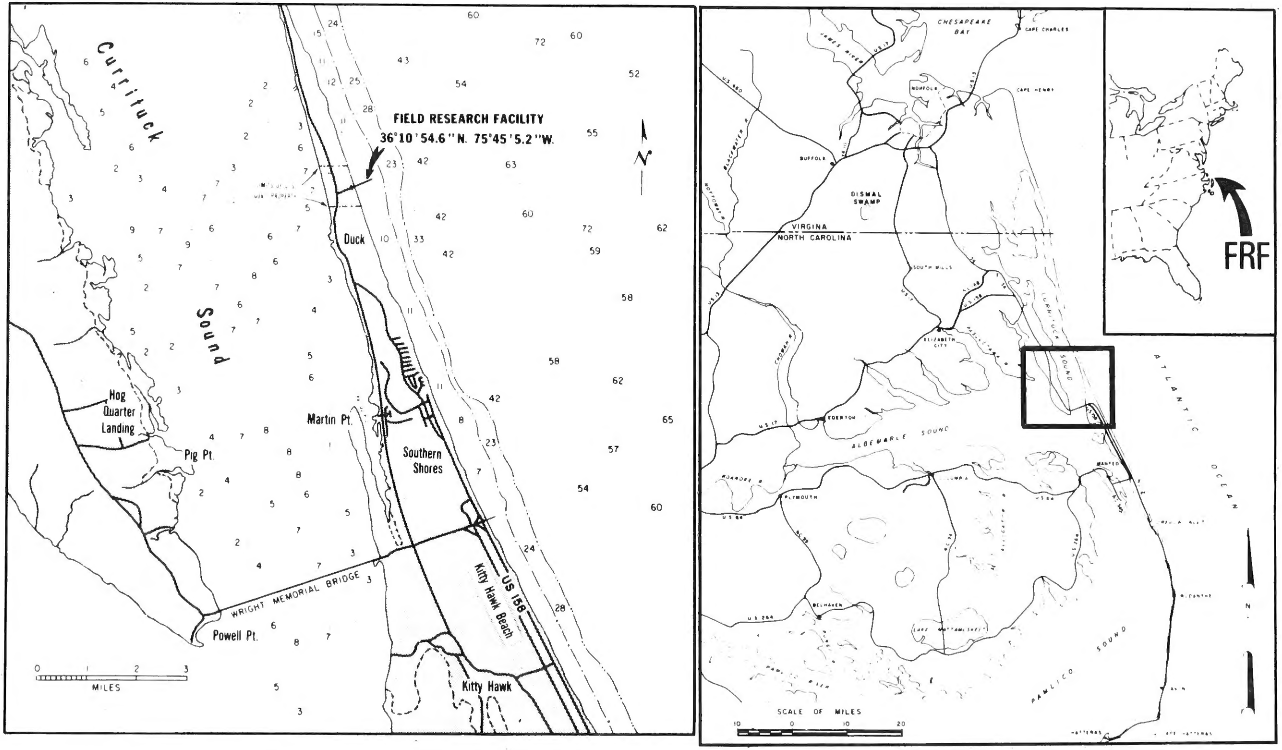

Figure 1. FRF location map.

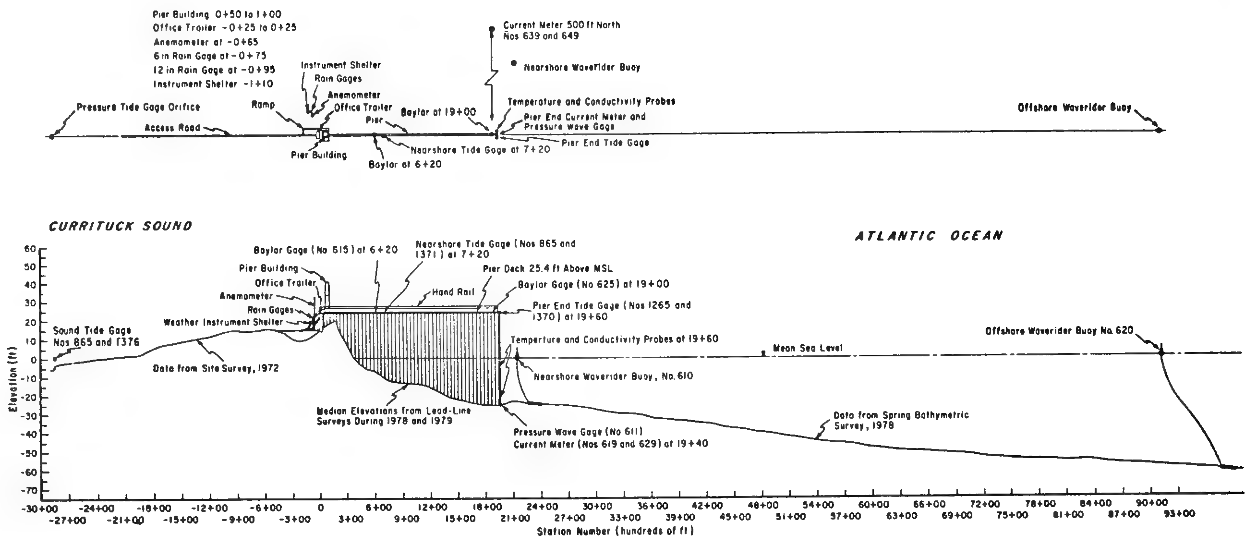

Figure 2. Instrument locations at FRF.

a. Staff Wave Gages. Three staff gages are used to collect wave data as part of the BEM. Two gages are located at stations 6+20 and 19+00; the third gage is located at Jennette's fishing pier (about 25 miles south of the FRF), Nags Head, North Carolina.

The wave staffs are parallel inductive cable types manufactured by the Baylor Company, Houston, Texas (Fig. 3). Each wave staff consists of two wire ropes 0.5 inch in diameter held parallel under tension 9 inches apart. Associated with each staff is a transducer element which yields an electrically linear (direct current) output that is proportional to the amount of cable above a short circuit on the staff caused by the conducting characteristics of seawater. The gage is designed for an accuracy and resolution of 1 and 0.1 percent full scale, respectively. (For additional details on the wave staffs, refer to Baylor Company, 1970.) The gage installations at stations 6+20 and 19+00 use a hanger bracket support at the top and an anchor system on the bottom which are centered under the pier deck midway between adjacent pilings (Fig. 3). The Nags Head staff has rigid top and bottom supports connected directly to a wooden piling on the north side of the pier.

The water depth at each gage fluctuates as a function of both the water level and bottom elevation. Figure 4 shows the maximum and minimum bottom elevations observed along the FRF pier between 27 July 1977 and 4 January 1979.

b. Wave Measuring Buoys. Two Datawell Waverider buoy wave sensors are deployed at the FRF (Fig. 5). One sensor is located near the seaward end of the pier in about 23 feet of water; the other sensor is 1.3 miles due east of the end of the pier in about 60 feet of water (Fig. 2). The Waverider is a buoy which follows the movement of the water surface with internal electronics that measure the vertical acceleration of the buoy. The signal is integrated twice to produce a surface displacement signal which is telemetered to a shore receiving station.

The mooring used to fix the buoy in position is an integral part of the wave measuring system, designed to allow the buoy to move freely with the sea surface but strong enough to withstand the large forces caused by storm waves. Figure 6 shows the nearshore and offshore Waverider mooring systems at the FRF. The mooring components and their dimensions are a function of the water depth where the buoys are deployed. The offshore mooring system (deployed in about 60 feet of water) consists of a black rubber stretch cord, a buoyant polypropylene white rope, and a nylon-covered, stainless-steel rope covered with an air compressor hose cut into 8-inch lengths (foreground of photo in Fig. 6). The air compressor hose protects the rope from abrasion as it is dragged back and forth on the ocean bottom. The nearshore mooring system consists only of the rubber cord for deployment in depths of 25 feet or less (background of photo in Fig. 6). Additional details on the buoy operation and mooring configuration are in Van Breugel, Verhagen, and Gerritzen (1972).

c. Pressure Wave Gage. A single pressure gage is installed under the seaward end of the FRF pier. The gage sensor consists of a transducer (manufactured by I.C. Transducers, Inc., San Jose, California), coupled to a Bellofram gage protector and enclosed in a PVC housing (Fig. 7). With this arrangement, the pressure is sensed by the diaphragm in the gage protector and transmitted by an oil-filled cavity to the transducer. (Additional details on the transducer may be obtained from the manufacturer.) The gage is located at station 19+40 in approximately 27 feet of water (Fig. 2). The pressure sensor is attached to a special T-shaped bracket anchored to the bottom (Fig. 8).

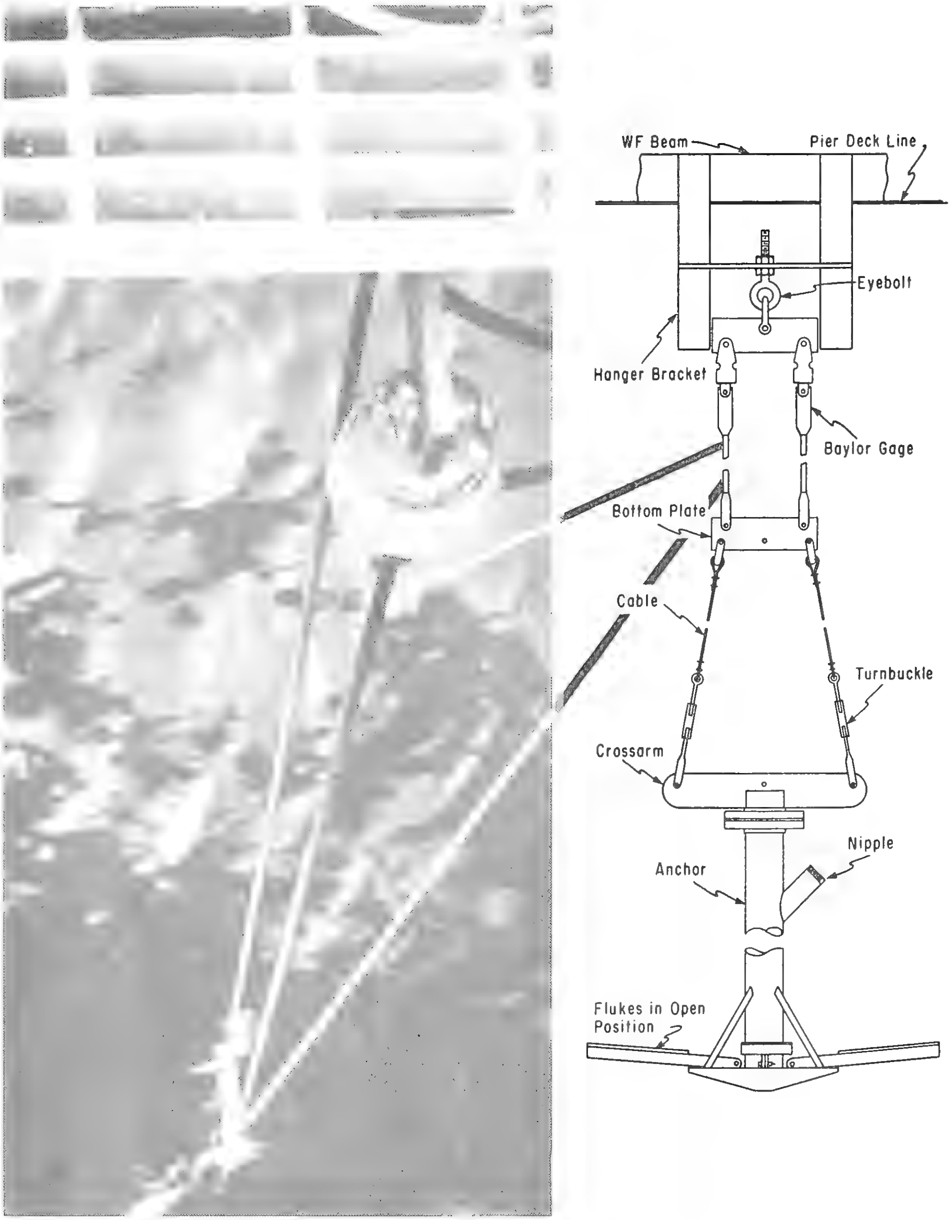

Figure 3. Baylor wave staff gage and support system.

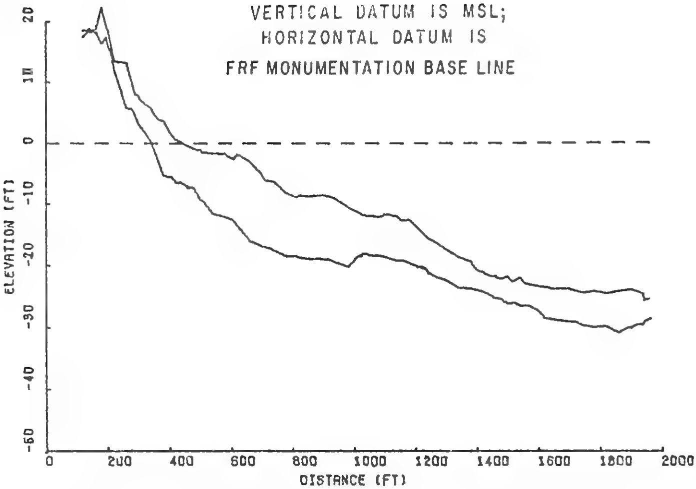

Figure 4. Water depth envelope along the FRF pier,
27 July 1977 to 4 January 1979.

Figure 5. Waverider buoys.

Figure 6. Waverider moorings.

Figure 7. Pressure wave gage.

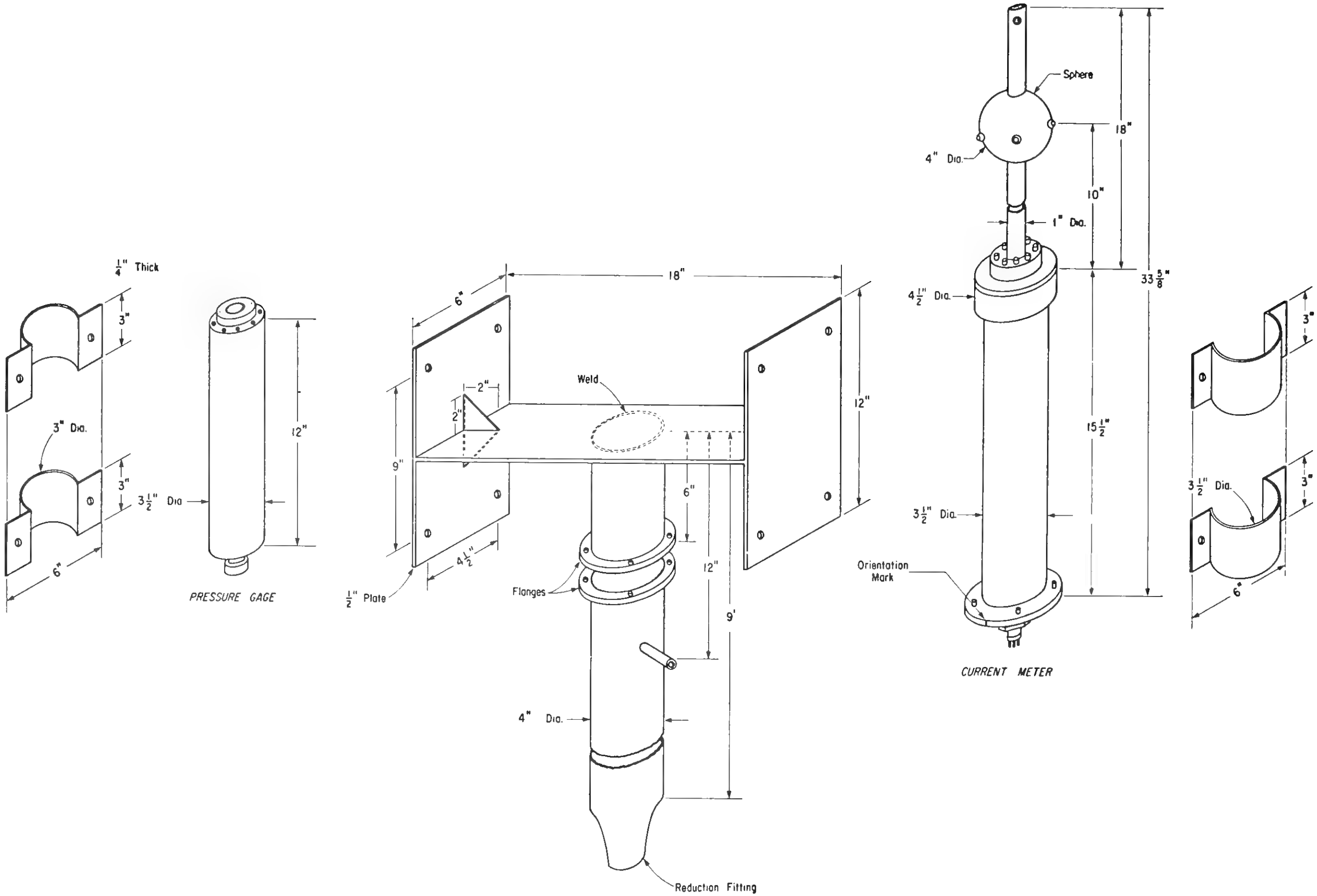

Figure 8. T-bracket used for current meter and pressure gage installation.

d. Current Meters. Two Marsh-McBirney (MMI) 551 electromagnetic current meters are deployed at the FRF, one at station 19+40 under the seaward end of the pier and the other at approximately the same distance from shore but 500 feet north of the pier (Fig. 2). The meter under the pier is attached to the T-bracket shown in Figure 8; the other meter installation is shown in Figure 9. The MMI current meters are solid-state instruments with no moving parts. The meter's operation is based on Faraday's principle of electromagnetic induction, i.e., a conductor moving through a magnetic field will produce a voltage proportional to the speed of the conductor. The probe for the meter consists of a 4-inch-diameter sphere which contains an electromagnet and two pairs of electrodes. The two orthogonal electrode pairs sense the vector component voltages induced when the water moves through the magnetic field produced by the electromagnet. The instrument range is ±10 feet per second with an accuracy of ±2 percent or ±0.07 foot per second and a 0.2-second time constant; zero drift is less than 0.07 foot per second. Additional details on the MMI 551 meters are in Marsh-McBirney, Inc. (1978).

e. Conductivity and Temperature Meters. Two Hydrolab Model TC-2 conductivity probes (Fig. 10) and two Hydrolab Model T-4 temperature probes (Fig. 11) are located under the seaward end of the pier at station 1960. One conductivity and one temperature probe is 10 feet below MSL; the other pair is 22 feet below MSL. The TC-2 determines the total concentration of ions in solution using the four-electrode method of conductivity measurement. The method consists of separating the electrodes that supply the current in the conductivity cell from the electrodes that measure the voltage produced in the solution by passage of the current through the cell. This technique eliminates errors due to cable resistance and electrode polarization, and diminishes the effects of electrode fouling (Garner, 1972). Measurements of conductivity also vary with temperature; the TC-2 instruments are electronically corrected to 25° Celsius for temperature variations. Water temperature is measured by the TC-2 using a precision thermistor temperature sensor contained in the conductivity probe. The conductivity output data signal is stated to be accurate to within 2.5 percent of the reading and the temperature readings to within ±0.5° Celsius. Mounted a few inches above the TC-2 probes are T-4 Marine Hydrographic thermometers which have a range from -2° to 49° Celsius. The conductivity and temperature values are obtained by reading Hydrolab meters located in a stainless-steel box on the pier deck (Fig. 12). (Additional details on the conductivity and temperature probes may be obtained from the Hydrolab Corporation, Austin, Texas.)

f. Tide Gages. Three NOS tide stations consisting of four gages are installed at the FRF. The NOS control station (Fig. 13) at the seaward end of the research pier (Fig. 2) consists of a Leupold-Stevens gage (Fig. 14; manufactured by Leupold and Stevens, Inc., Beaverton, Oregon) and a Bristol pressure gage (Fig 15; manufactured by the Bristol Company, Waterbury, Connecticut). The second tide station (located at station 7+20) has a Fischer-Porter tide gage (Fig. 16; manufactured by Fischer and Porter Company, Warminster, Pennsylvania). The third station (located about 1,000 feet west of the shore in the Currituck Sound) has a Metercraft pressure tide gage (Fig. 17; manufactured by Metercraft Corporation, Perry Hall, Maryland).

Both the Leupold-Stevens and Fischer-Porter analog-to-digital recorders (ADR) are float-activated, negator-spring, counterpoised instruments that mechanically convert the vertical motion of a float into a coded, punched

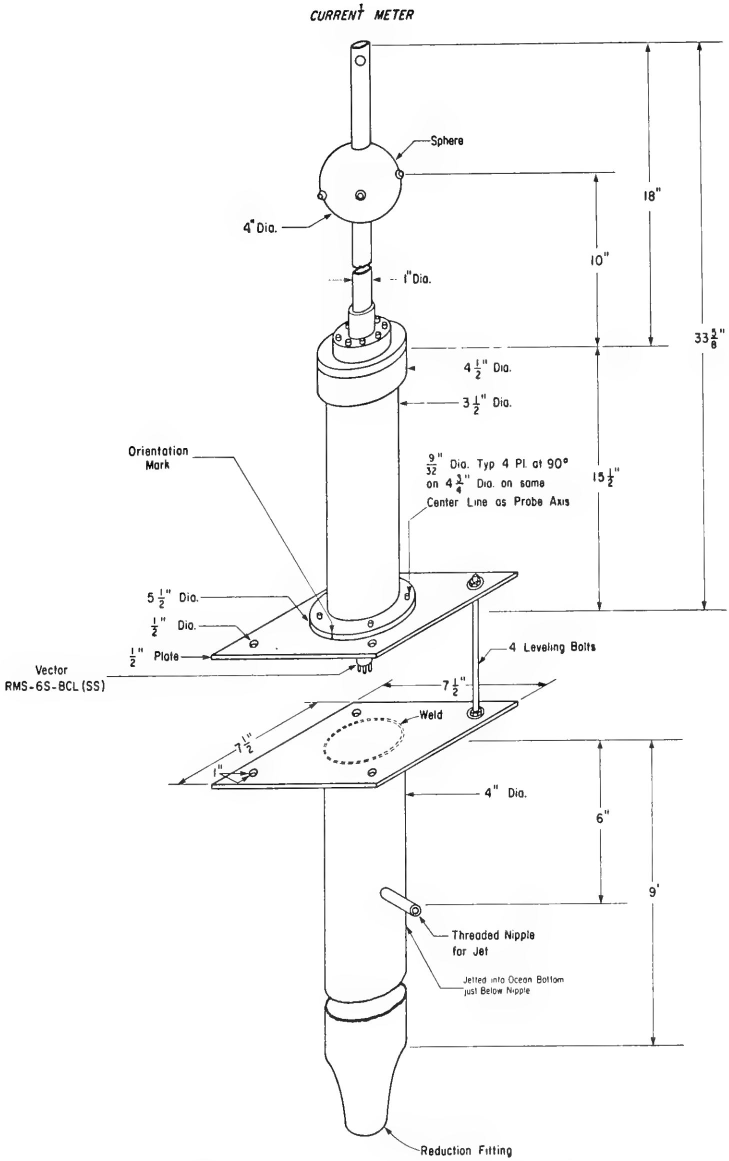

Figure 9. Current meter installation.

Figure 10. Hydrolab Model TC-2 conductivity probe.

Figure 11. Hydrolab Model T-4 temperature probe.

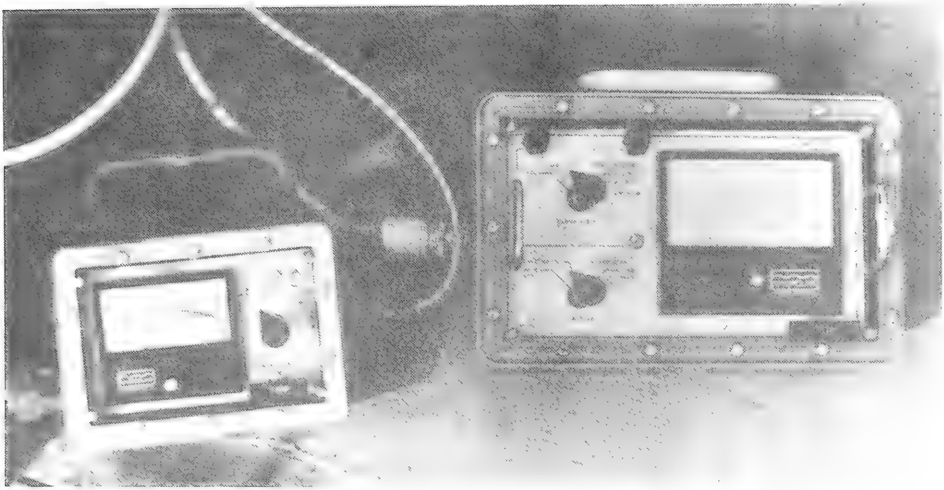

Figure 12. Hydrolab temperature and conductivity meters.

Figure 13. NOS control station at end of pier.

Figure 14. Leupold-Stevens tide gage.

Figure 15. Bristol pressure tide gage.

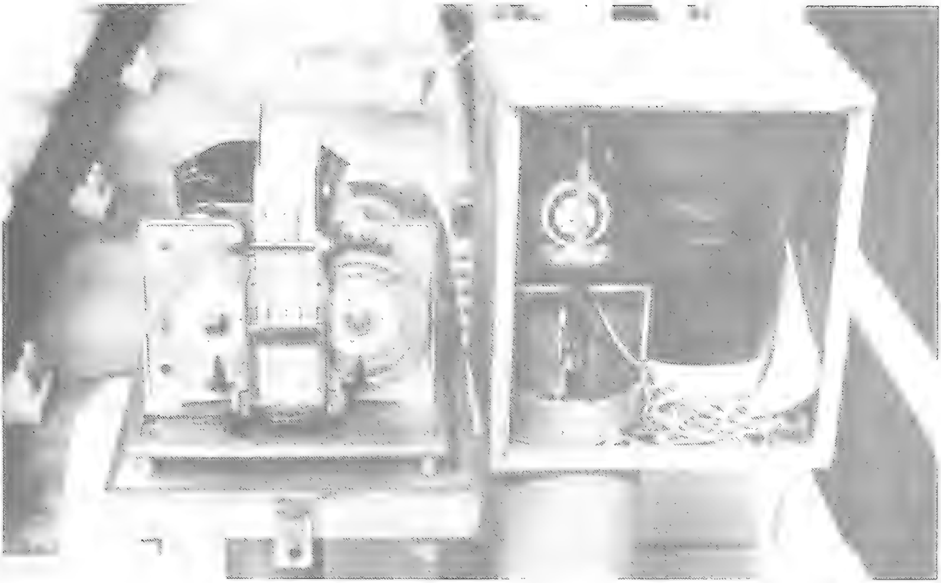

Figure 16. Fischer-Porter tide gage.

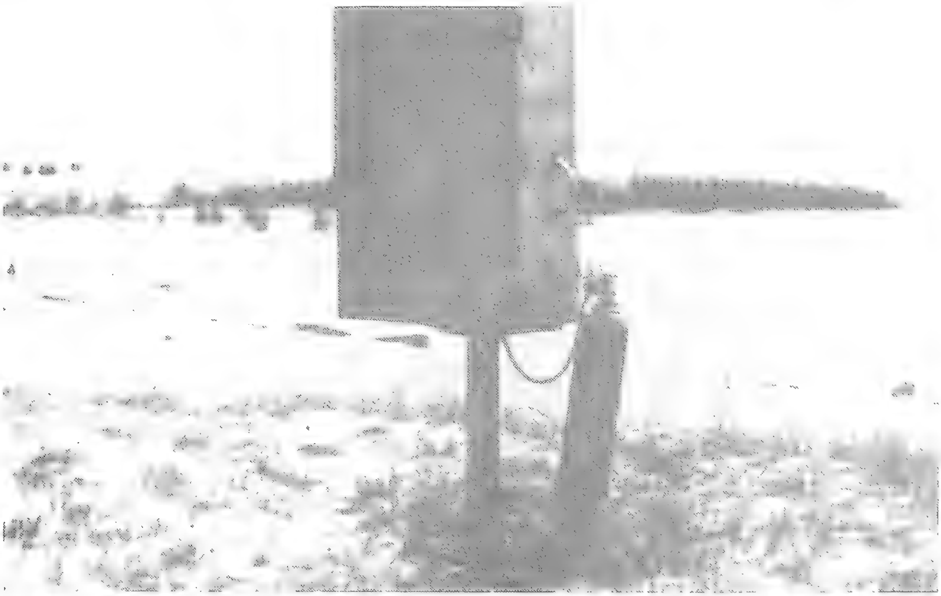

Figure 17. Metercraft pressure tide gage.

paper-tape record. The below-deck installations at stations 19+60 and 7+20 consist of 12-inch-diameter stilling wells with a 1-inch orifice and 0.5-inch orifice, respectively, and an 8.5-inch float (Fig. 18). The stilling well acts as a high-frequency filter to dampen the effects of waves, thereby giving accuracy to the measurements of water level fluctuations produced by the tide. The float, which responds to any variation in the water column within the stilling well, is coupled to a float-wire takeup drum and input shaft assembly via a stainless-steel wire. The angular position of the input shaft is recorded on paper tape every 6 minutes in a standard binary-decimal code.

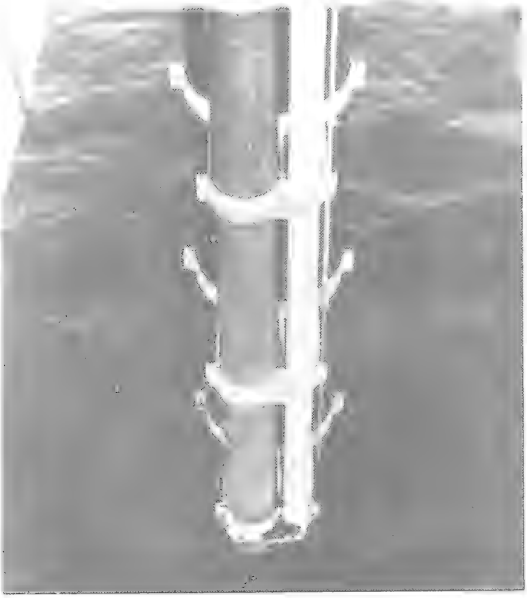

Figure 18. Stilling well.

The Bristol and Metercraft pressure gages measure the hydrostatic pressure created by a column of water above a submerged orifice. The orifice and the recording instrument are linked by a nitrogen-filled, plastic supply line. Any change in the hydrostatic pressure, such as that caused by the rise and fall of the tide, is transmitted to the recorder where the pressure variations are recorded on a strip chart as changes in water depth.

To monitor tide gage operation and provide datum information, electric tape gages have been installed at stations 19+60 and 7+20 in lieu of a tide staff. The operating principle of the tape gage is based on the electrical conductivity of seawater. The gage consists of a stainless-steel tape on a takeup reel, 6-inch-diameter stilling well, voltmeter, and battery. The weighted tape, graduated to hundredths of a foot, completes an electrical circuit upon contact with the seawater inside the metal stilling well. The distance to the water level at that instant is measured below a reading mark on the tape. The reading mark has a known elevation relative to tidal bench marks and the National Geodetic Vertical Control Network. The electric tape gage readings are compared with the automatically recorded tide record. Additional details on each gage may be obtained from the respective manufacturer.

2. Meteorological Instrumentation.

To monitor the meteorological conditions at the FRF, various equipment has been installed by the NWS and CERC. Figure 2 shows the location of the meteorological instruments. Although CERC is responsible for collecting the data, NWS provides guidance on installations and maintains the anemometer. In addition to any permanent records obtained from the devices with recording capabilities, each instrument is read daily (at approximately 0700 hours). Additional details on the instruments described below may be obtained from the respective manufacturer or from NWS.

a. Anemometer. A model F420C anemometer is used to measure wind speed and direction (Fig. 19). A cup rotor and a spread-tail wind vane were installed on a 21-foot-high tower about 65 feet from a temporary office trailer. The anemometer is coupled to wind speed and direction gages inside the trailer to monitor the onshore wind conditions (Fig. 20). The gages are manufactured by the Electric Speed Indicator Company, Cleveland, Ohio.

Figure 19. A model F420C anemometer used to measure wind speed and direction.

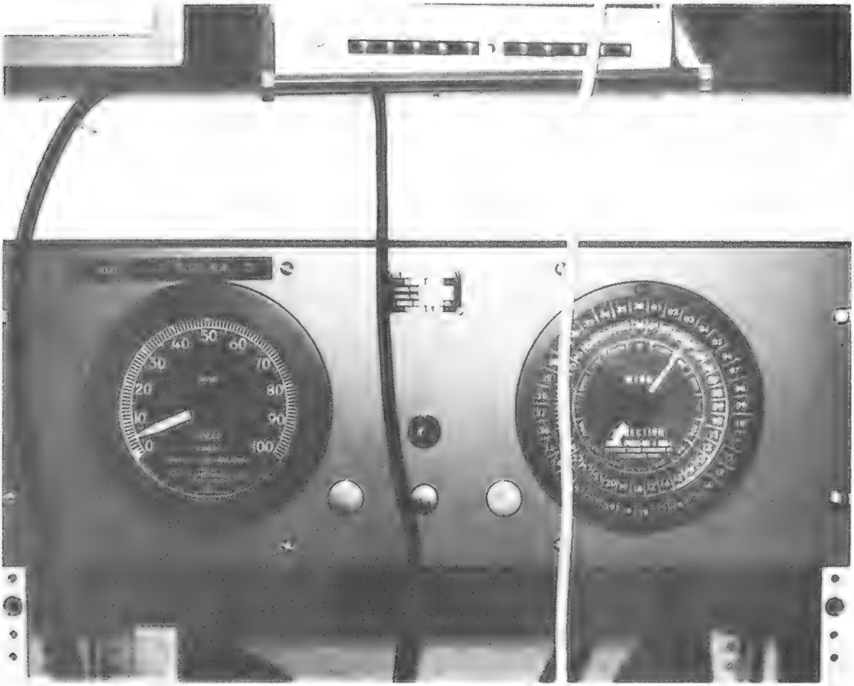

Figure 20. Wind speed and direction gages.

The accuracy of the speed transmitter and indicator assemblies is ±1 knot from 2- to 100-knot winds and ±2 knots for 100- to 200-knot winds at 20° to 25° Celsius. The wind-direction transmitter and indicator assemblies are accurate to ±5° at an airspeed of 5 knots or greater for any horizontal direction at 20° to 25° Celsius.

The wind-direction transmitter assembly includes a direction transmitter body and a spread-tail wind vane. The transmitter body consists of a 12-volt (direct current) synchro transmitter coupled to the wind-vane shaft. The moment of inertia of the vane is approximately 583,000 gram-centimeters squared. The synchro transmitting element gives a minimum resistance to the electrical current when the vane is directed to due north and increases the resistance as the vane turns away from north. Two potentiometers are used to determine which direction the vane has turned with respect to north.

The windspeed transmitter includes a windspeed transmitter body and a cup rotor. A direct-current magneto is coupled to the cup rotor and provides a voltage-versus revolution-per-minute ratio of 0.004007 with an electrical load of 428.6 ohms. The terminal resistance of the magneto is 40 ohms ±1 ohm; the moment of inertia of the cup rotor and magneto armature is 70,700 gram-centimeters squared (maximum). National Weather Service (1979) provides additional details on the wind measuring system. In late 1979, an analogue recorder was installed to provide continuous records of the wind speed and direction.

b. Microbarograph. This instrument, manufactured by the Belfort Instrument Company, Baltimore, Maryland, is located inside the building and is used to measure the atmospheric pressure and pressure tendency (Fig. 21). The device is an aneroid sensor which responds to pressure changes on the order of 0.005 inches of mercury. The pressure tendency can be determined from the chart record; i.e., the total change in pressure over a 3-hour period and the direction of change (increasing, decreasing, or some combination).

Figure 21. Microbarograph.

c. Barometer. A NWS barometer is also used for monitoring atmospheric pressure (Fig. 22). This device is an aneroid barometer with a 2-inch-diameter bimetallic wafer which expands or contracts with changes in pressure. The pressure (in inches) is read directly off the gage. Additional details on the barometer can be provided by the Basic Observations Branch, NWS.

d. Hygrothermograph. The hygrothermograph (Fig. 23) is located in an outdoor, ventilated instrument shelter (Fig. 24). This instrument, also manufactured by the Belfort Instrument Company, is used to measure and record both air temperature and relative humidity. The temperature sensor consists of a bimetal assembly made from two dissimilar metals which react to temperature changes at different rates. The recording styles (or pens) are driven by the expansion or contraction of the assembly. The relative humidity is sensed by

Figure 22. NWS barometer.

Figure 23. Hygrothermograph.

Figure 24. Wood shelter which houses the hygrothermograph.

a banjo-spread human hair element which expands when the humidity increases and contracts when it decreases, causing the second recording pen to deflect approiately. In addition to the daily observations, a 7-day continuous chart record is produced.

e. Maximum and Minimum Thermometers. The NWS thermometers (housed in the instrument shelter) are used to determine the daily extreme temperatures (Fig. 24). A constriction in the capillary of the maximum thermometer prevents the mercury from flowing back into the bulb. The mercury is forced past the constriction as the temperature rises but does not return through it when the temperature falls, causing a thread of mercury to remain in the tube at the highest temperature reached. The thermometers are held in a special mounting device called a Townsend Support (see Fig. 23) which allows a reset of the thermometers without removal. The high temperature thermometer is reset by spinning it in the Townsend Support, thereby causing enough centrifugal force to force the mercury back through the constriction.

The minimum thermometer has a small, dark glass index in the thermometer bore which is pulled toward the bulb by the surface tension of the mercury meniscus as the temperature drops and remains stationary when the temperature rises. The thermometer is mounted horizontally except when the instrument is reset. Resetting is facilitated by the Townsend Support and consists of raising the bulb of the thermometer, thus causing the index to slide downward (toward higher temperatures) in the tube. The thermometers are read and reset once a day. Additional details on the thermometers can be provided by the Basic Observations Branch, NWS.

f. Twelve-Inch Weighing Rain Gage. This gage (manufactured by the Belfort Instrument Company, Baltimore, Maryland) is used to measure and record the daily amount of precipitation (Fig. 25), and is located near the instrument shelter (Fig. 2). The gage sensor consists of a 1-foot-high collection bucket (8 inches in diameter), a weighing mechanism connected to the recorder pen, and a chart drive for continuously recording the amount of precipitation. The weighing device is a spring scale connected through a lever mechanism to a pen that moves across the chart. The rain capacity is expressed in inches but is measured in terms of weight; i.e., 1 inch is 29.02 ounces at 62.56° Celsius. The manufacturer's specifications indicate that the instrument accuracy is 0 to 6 inches ±0.5 percent (±0.03 inch of precipitation) and 6 to 12 inches ±1.0 percent (±0.06 inch of precipitation). Daily observations of the total precipitation are recorded and the chart records are retained for future reference.

Figure. 25. Recording rain gage.

g. Six-Inch Plastic Rain Gage. The 6-inch rain gage (a True Check Rain Gage manufactured by the Edwards Manufacturing Company, Alberta Tea, Minnesota) (Fig. 26) is located about 25 feet from the 12-inch weighing rain gage (Fig. 2). The gage is simply a catch with a calibrated scale and is used as a check for the 12-inch weighing rain gage. Daily totals are recorded and the gage is manually (emptied) reset.

Figure 26. Six-inch plastic rain gage.

h. Sling Psychrometer. A sling psychrometer is used to measure relative humidity and to determine the dew point (Fig. 27). The psychrometer has two thermometers mounted in a frame which can be rotated rapidly. A moistened muslin wick is attached to the bulb of one of the thermometers and the device is whirled to ventilate both thermometers. The temperature is read from both the "wet" and the "dry" bulb thermometers and a set of tables is used to obtain the relative humidity and dew point values from the different temperatures. The dew point is recorded daily along with the other meteorological observations. Additional details on the sling psychrometer can be provided by the Basic Observations Branch, NWS.

i. Mechanical Pyranograph. This device, located on top of the weather instrument shelter and made by the Weather Measure Corporation, Sacramento, California, provides a continuous record of the intensity of the sun and sky radiation (Fig. 28). Two black and two white bimetallic strips are coupled together with the black strips attached through a linkage to the recording pen. As the radiation heats the black strips, the pen deflects. The white strips provide compensation for ambient temperature changes. The area under the curve on the chart record is a measure of the total radiation. The chart records are collected and stored without analysis.

Figure 27. Sling psychrometer.

Figure 28. Mechanical pyranograph.

III. SAMPLING INFORMATION AND SUMMARY DESCRIPTIONS

1. Digital Wave Data.

Routinely, four digital records per day at times near 0100, 0700, 1300, and 1900 e.s.t. are obtained from the CERC wave gages. Each record is 20 minutes long with a sample frequency of four data points per second. Thompson (1977) describes the method used to analyze the digital data records. Monthly summaries of significant wave height and peak spectral period are available for dissemination.

For the pressure-wave gage, the surface pressure record is attenuated with depth. In order for the pressure record sensed by the gage to reflect surface conditions, linear wave theory is used to compensate for the hydrodynamic attenuation; Esteva and Harris (1970) provide a discussion of the compensation technique used by CERC. These data are sampled at 4 hertz for a 20-minute period as are the other wave sensors.

The FRF wave data are summarized in the standard CERC monthly wave data summary format which consists of (a) a listing of the significant wave height and peak spectral wave period by day and time (Fig. 29), (b) a joint distribution of significant wave height versus peak spectral period (Fig. 30), and (c) a graph of the significant wave height and peak spectral period versus time (Fig. 31). When requested, the spectral energy distribution as a function of wave frequency can be printed or plotted (Fig. 32).

2. Current Meter Data.

The current meter data are obtained as x and y components of velocity four times a day for 20 minutes at a frequency of four data points per second. The statistical package is designed to treat the data exactly like wave height information. Consequently, for each current component the mean of the data record, the standard deviation, and the spectral energy distribution are computed. The only summarization is in the form of Figure 29 where a listing of the mean current, standard deviation, and peak spectral period as a function of the day and time is generated.

3. Conductivity and Temperature Data.

The conductivity and temperature gages are read once daily and the data are recorded as notes on the CERC Littoral Environmental Observation (LEO) forms for the pier end LEO site. The LEO visually observed data are summarized by computer after the data have been punched on cards. An analog recorder (installed in April 1980) is used for continuously recording the water conductivity and temperature.

4. Monthly Tide Summaries.

The paper tapes and strip-chart records are sent to the NOS, Rockville, Maryland, where monthly tabulations of hourly tide heights and high and low water level summaries are prepared. Copies of the tabulated summaries are forwarded to CERC. Tidal datums at the FRF are computed by the NOS office. An example of the NOS hourly and high and low water summaries for 1 month of data is shown in Figure 33.

625 FRF DUCK, NC JAN 1978 SIGNIFICANT WAVE HEIGHTS AND PERIODS ID= 625

DAY/TIME	0100 H(CM)	0100 H(FT)	0100 T(SEC)	0700 H(CM)	0700 H(FT)	0700 T(SEC)	1300 H(CM)	1300 H(FT)	1300 T(SEC)	1900 H(CM)	1900 H(FT)	1900 T(SEC)
1	170.69	5.60	8.79	157.28	5.16	8.79	162.15	5.32	10.84	141.43	4.64	9.71
2	91.44	3.00	10.84	76.81	2.52	10.84	95.10	3.12	10.84	80.47	2.64	12.26
3	67.06	2.20	12.26	62.18	2.04	10.84	76.81	2.52	4.31	65.84	2.16	6.38
4	60.96	2.00	5.01	95.10	3.12	5.01				60.96	2.00	4.75
5	42.67	1.40	5.29	30.48	1.00	10.84						
6										43.89	1.44	6.38
7	52.43	1.72	6.38	40.23	1.32	5.61	47.55	1.56	6.85	84.12	2.76	9.71
8	95.10	3.12	8.03	108.51	3.56	8.03	124.36	4.08	9.71	151.18	4.96	12.26
9	178.00	5.84	8.79	220.68	7.24	12.26	114.60	3.76	10.84	92.66	3.04	14.12
10	82.91	2.72	12.26	78.03	2.56	12.26				47.55	1.56	12.26
11	80.47	2.64	4.75	151.18	4.96	6.38				68.28	2.24	4.52
12	49.99	1.64	14.12	40.23	1.32	14.12	37.80	1.24	14.12	48.77	1.60	12.26
13	49.99	1.64	12.26	80.47	2.64	3.95	121.92	4.00	8.03	196.29	6.44	9.71
14	249.94	8.20	12.26	199.95	6.56	12.26	152.40	5.00	12.26	143.87	4.72	10.84
15	113.39	3.72	10.84	129.24	4.24	10.84	151.18	4.96	10.84	117.04	3.84	12.26
16	89.00	2.92	12.26	75.59	2.48	10.84	70.71	2.32	12.26	71.93	2.36	12.26
17	58.52	1.92	10.84	64.62	2.12	12.26	91.44	3.00	4.75	210.92	6.92	8.79
18	197.51	6.48	9.71	135.33	4.44	10.84	110.95	3.64	10.84	97.54	3.20	9.71
19	153.62	5.04	4.75	108.51	3.56	5.01				185.32	6.08	5.61
20	264.57	8.68	6.85	207.26	6.80	8.79	170.69	5.60	9.71	129.24	4.24	10.84
21	132.89	4.36	9.71	74.37	2.44	9.71	74.37	2.44	10.84	67.06	2.20	14.12
22	73.15	2.40	12.26	119.48	3.92	12.26	121.92	4.00	12.26	90.22	2.96	12.26
23	75.59	2.48	12.26	78.03	2.56	12.26	93.88	3.08	12.26	74.37	2.44	12.26
24	65.84	2.16	10.84	65.84	2.16	10.84				52.43	1.72	9.71
25	53.64	1.76	9.71	57.30	1.88	9.71	85.34	2.80	9.71	110.95	3.64	8.79
26	153.62	5.04	9.71	206.04	6.76	9.71				93.88	3.08	10.84
27	82.91	2.72	10.84	60.96	2.00	9.71	49.99	1.64	9.71	39.01	1.28	9.71
28	34.14	1.12	10.84	40.23	1.32	16.65	49.99	1.64	7.39	62.18	2.04	10.84
29	85.34	2.80	5.01				67.06	2.20	5.61	69.49	2.28	5.01
30	70.71	2.32	5.29	78.03	2.56	5.97	90.22	2.96	5.97	78.03	2.56	5.97
31	69.49	2.28	6.38	60.96	2.00	5.61	74.37	2.44	5.61	67.06	2.20	5.01
COL AVG	101.52	3.33	9.30	100.10	3.28	9.73	97.16	3.19	9.37	94.73	3.11	9.64

AVERAGE SIGNIFICANT WAVE HEIGHT = 3.23 FEET AVERAGE WAVE PERIOD = 9.52 SEC 112 OBSERVATIONS

Figure 29. Example of the CERC monthly wave data summary for significant wave heights and periods.

WAVE CLIMATE FOR · 625 FRF DUCK, NC FOR 1 MONTH - JAN 78
DISTRIBUTION OF SIGNIFICANT HEIGHT VS PERIOD (IN OBSERVATIONS PER 1000 OBS)
FOR 112 OBSERVATIONS OF NON-CALM CONDITIONS- 0 OBSERVATIONS OF CALM CONDITIONS HAVE NOT BEEN INCLUDED

PERIOD (SECS)	SIGNIFICANT HEIGHT																
	0-1	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	10-11	11-12	12-13	13 +	TOTAL	ACC. TOTAL	ROW AVG
0.0 - .9																	0.00
1.0 - 1.9																	0.00
2.0 - 2.9																	0.00
3.0 - 3.9			9												9	9	2.50
4.0 - 4.9			36	9		9									54	62	3.17
5.0 - 5.9		18	98	18			9								143	205	2.75
6.0 - 6.9		27	18		9				9						62	268	3.21
7.0 - 7.9		9													9	277	1.50
8.0 - 8.9				27	9	27	18								80	357	4.94
9.0 - 9.9		45	36	9	27	18	27								161	518	3.61
10.0 -10.9		27	71	54	45	9									205	723	3.20
11.0 -11.9																723	0.00
12.0 -12.9		27	116	27	18	9	9	9	9						223	946	3.38
13.0 -13.9																946	0.00
14.0 -14.9		27	9	9											45	991	2.10
15.0 -15.9																991	0.00
16.0 -16.9		9													9	1000	1.50
17.0 -17.9																1000	0.00
18.0 -18.9																1000	0.00
19.0 -19.9																1000	0.00
20.0 -20.9																1000	0.00
21.0 +																1000	0.00
TOTAL		187	393	152	107	71	62	9	18							1000	3.29
ACC. TOTAL		167	580	732	839	911	973	982	1000	1000	1000	1000	1000	1000	1000	1000	
COL. AVG.	0.00	10.21	8.95	9.74	10.08	9.00	9.07	12.50	9.50	0.00	0.00	0.00	0.00	0.00	9.48		

AVERAGE SIGNIFICANT WAVE HEIGHT = 3.23 FT
VARIANCE OF SIGNIFICANT WAVE HEIGHT = 2.71 FT SQ
STANDARD DEVIATION OF SIG. HEIGHT = 1.64 FT

AVERAGE WAVE PERIOD = 9.52 SEC
VARIANCE OF WAVE PERIOD = 8.12 SEC SQ
STANDARD DEVIATION OF PERIOD = 2.85 SEC

(FOR THE ABOVE 3 LINES, CALM IS COUNTED AS 0.0 FEET FOR WAVE HEIGHT AND IS OMITTED FOR WAVE PERIOD)

RECORD OBTAINED WITH A BAYLOR STAFF wave gage located at station 19+00 (FRF pier).
DATA OBTAINED BY ANALYSIS OF A 1024-SECOND DIGITAL RECORD.

Figure 30. Example of the CERC monthly wave data summary for distribution of significant wave height versus period.

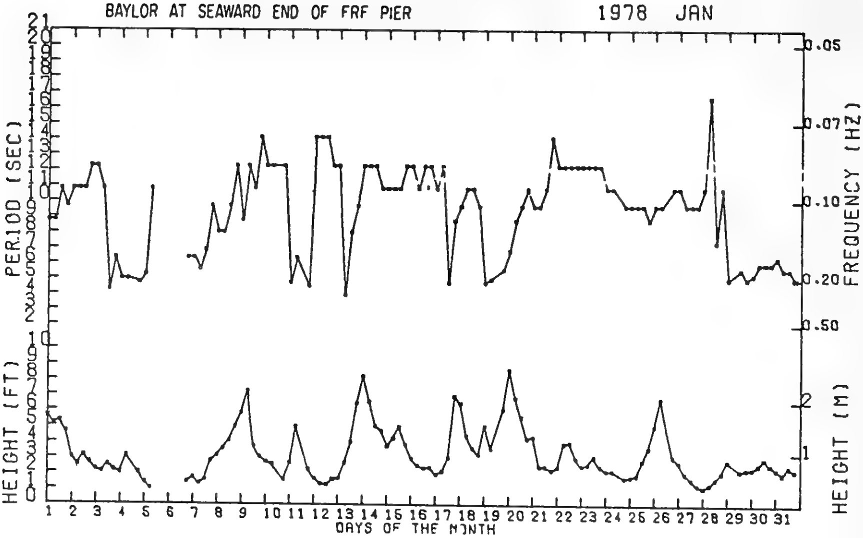

Figure 31. Example of graph showing significant wave height and period versus time.

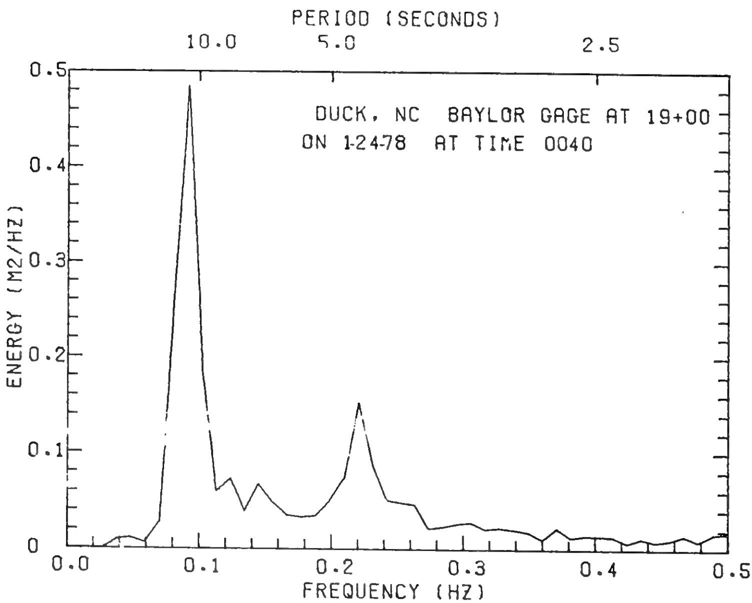

Figure 32. Example of spectrum plot.

NATIONAL OCEAN SURVEY (NOAA)
TIDES, HIGH AND LOW WATERS (FEET)

8651370 DUCK FRF NC (OUTSIDE) SEP 1978 TM 75W

DAY	TIME HIGH	TIME LOW	HEIGHT HIGH	HEIGHT LOW	DAY	TIME HIGH	TIME LOW	HEIGHT HIGH	HEIGHT LOW
1	6,2	0,6	21,32	18,37	17	7,3	1,2	22,73	17,87
	18,7	11,9	22,25	18,62		19,4	13,8	22,71	18,21
2	7,1	0,8	22,29	18,99	18	7,9	1,9	22,75	18,27
	19,1	13,1	22,36	19,02		20,5	14,4	22,44	18,27
3	7,6	1,6	22,39	18,94	19	8,7	2,6	22,59	18,37
	19,4	13,6	22,41	19,00		20,9	15,1	23,01	18,80
4	8,4	1,9	22,38	18,72	20	9,7	3,1	23,50	19,69
	20,2	14,3	22,41	19,14		22,1	16,4	22,28	19,41
5	8,8	2,5	22,32	18,75	21	10,1	4,3	22,55	19,09
	21,1	14,9	22,12	18,98		22,8	17,1	21,66	19,03
6	9,4	3,4	22,24	18,84	22	11,3	4,9	21,83	18,72
	21,8	15,8	21,98	18,93		23,7	17,6	21,60	18,84
7	10,4	4,1	22,13	18,66	23	12,1	4,9	23,21	19,70
	22,9	16,6	21,51	18,74		—	18,7	—	20,57
8	11,3	4,8	22,45	18,67	24	0,4	7,1	22,37	20,13
	23,5	17,7	22,15	19,38		13,0	19,9	22,48	19,96
9	12,8	5,4	22,57	19,01	25	1,7	8,1	21,76	19,70
	—	18,8	—	19,65		14,2	20,6	22,03	19,66
10	0,4	6,5	22,22	19,35	26	2,2	8,7	21,83	20,05
	13,4	19,9	22,58	19,45		15,2	21,5	22,48	20,00
11	1,5	8,2	22,04	19,11	27	3,4	9,9	22,17	19,84
	14,1	20,9	22,35	18,68		15,9	22,5	22,33	19,68
12	2,7	9,1	21,48	18,34	28	4,6	10,8	22,10	19,64
	15,3	21,9	22,23	18,36		16,7	23,2	22,32	19,69
13	4,0	9,5	21,79	18,78	29	5,4	11,5	22,60	19,65
	16,9	23,1	23,98	20,03		17,7	23,6	22,57	19,35
14	4,9	11,1	23,29	19,13	30	5,7	12,3	22,35	19,20
	17,4	23,4	23,47	18,82		18,1	—	22,51	—
15	5,9	12,0	22,88	18,39					
	18,0	—	23,02	—					
16	6,8	0,8	22,71	18,24					
	18,9	12,8	22,85	18,19					

MHW 22,40 MLW 19,08 MSL 20,75 MN 3,32 MTL 20,74

MTL-MSL -0,01 MHHW 22,58 MLLW 18,93 DHQ 0,18 DLQ 0,15

GT 3,65 (DRL)TL 20,75 (DRL)TL-MSL -0,00

GMHWI 12,29 HRS GMLWI 6,18 HRS

HIGHEST TIDE 23,98 16,9 HRS SEP 13

LOWEST TIDE 17,87 1,2 HRS SEP 17 DATUM IS ....

74 M 30 (7/31 8) (9/ 1 15) 0,11 248,9 = ( ) INFERRED
(9/ 1 20) (10/ 1 7) 0,14

NATIONAL OCEAN SURVEY (NOAA)
TIDES, HOURLY HEIGHTS (FEET)

8651370 DUCK FRF NC (OUTSIDE) SEP 1978 TM 75W

DAY OF MONTH

HOUR	1	2	3	4	5	6	7	8	9	10	11
0	18,49	19,21	19,40	19,78	20,30	20,88	21,25	21,21	21,94	22,09	21,73
1	18,54	19,03	18,95	18,99	19,42	19,97	20,37	20,56	21,59	22,08	21,91
2	18,82	19,29	19,02	18,70	18,54	19,23	19,55	19,90	21,05	21,71	21,95
3	19,39	19,73	19,44	19,02	18,87	18,87	18,88	19,21	20,31	21,07	21,76
4	20,27	20,56	20,05	19,48	19,16	18,95	18,62	18,79	19,50	20,44	21,22
5	20,99	21,23	20,96	20,15	19,77	19,41	18,77	18,71	19,11	19,78	20,45
6	21,29	21,95	21,70	21,18	20,67	20,03	19,34	18,93	19,07	19,43	19,75
7	21,24	22,28	22,27	22,04	21,60	21,03	20,01	19,64	19,27	19,39	19,34
8	21,17	22,11	22,30	22,34	22,18	21,88	20,84	20,36	19,72	19,59	19,17
9	20,40	21,62	21,98	22,34	22,32	22,22	21,78	21,33	20,59	20,16	19,31
10	19,83	20,88	21,37	21,77	22,05	22,19	22,08	22,16	21,66	20,83	19,86
11	19,14	20,00	20,61	21,20	21,55	21,88	21,92	22,38	22,32	21,78	20,67
12	18,62	19,33	19,72	20,30	20,65	21,22	21,49	22,31	22,49	22,30	21,56
13	18,82	19,03	19,16	19,53	19,87	20,35	20,79	21,96	22,54	22,54	22,16
14	19,29	19,18	19,08	19,14	19,24	19,58	20,06	21,30	22,17	22,40	22,32
15	19,97	19,65	19,39	19,20	18,54	19,02	19,21	20,53	21,45	22,05	22,2[illegible]
16	20,74	20,38	20,05	19,67	19,19	18,99	18,89	19,91	20,67	21,50	21,82
17	21,61	21,36	20,83	20,24	19,59	19,25	18,79	19,53	20,10	20,60	21,17
18	22,05	22,04	21,71	21,19	20,24	19,72	19,02	19,38	19,82	20,00	20,19
19	22,19	22,34	22,38	21,98	21,26	20,38	19,45	19,81	19,68	19,57	19,37
20	21,91	22,28	22,41	22,41	21,83	21,27	20,22	20,36	19,93	19,47	18,82
21	21,35	21,81	22,14	22,28	22,12	21,83	20,95	20,99	20,53	19,74	18,66
22	20,60	21,05	21,53	21,88	22,03	21,96	21,38	21,68	21,23	20,32	18,84
23	19,88	20,26	20,74	21,17	21,66	21,71	21,55	22,02	21,86	21,14	19,49

Figure 33. Example of NOS tide summary.

NATIONAL OCEAN SURVEY (NOAA)
TIDES, HOURLY HEIGHTS (FEET)

8651370 DUCK FRF NC (OUTSIDE) SEP 1978 TM 75W

DAY OF MONTH

HOUR	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
0	20.26	19.32	20.13	19.76	18.29	18.38	19.33	20.13	21.87	21.57	21.36	21.54	22.27	21.50	20.81	20.62	20.06	19.83	19.42
1	20.90	20.16	20.74	19.27	18.19	17.97	18.52	19.01	20.67	20.87	20.91	21.13	22.30	21.67	21.36	21.15	20.50	20.18	19.55
2	21.39	21.05	21.74	19.59	18.71	18.17	18.31	18.47	20.12	20.05	20.23	21.04	22.11	21.77	21.83	21.72	21.19	21.00	20.21
3	21.47	21.60	22.65	21.16	19.73	18.88	18.72	18.38	19.77	19.37	19.54	20.57	21.73	21.60	21.70	22.13	21.73	21.74	20.90
4	21.19	21.79	23.24	22.16	20.59	19.87	19.27	18.67	19.83	19.11	18.89	20.07	21.12	21.22	21.55	22.12	22.02	22.20	21.64
5	20.72	21.59	23.33	22.46	22.02	21.20	20.39	19.45	20.20	19.20	18.70	19.69	20.56	20.66	21.43	21.89	21.99	22.51	22.18
6	20.00	21.07	23.11	22.88	22.65	22.29	21.64	20.53	20.67	19.57	18.65	20.08	20.20	20.15	20.99	21.63	21.82	22.49	22.39
7	19.21	20.25	22.30	22.50	22.70	22.70	22.47	21.69	21.96	20.34	19.36	20.22	20.13	19.82	20.44	20.86	21.28	22.03	22.22
8	18.69	19.49	21.42	21.71	22.30	22.57	22.72	22.49	22.87	21.18	20.02	20.80	20.28	19.69	20.10	20.22	20.63	21.46	21.60
9	18.41	18.92	20.26	20.55	21.39	22.07	22.52	22.54	23.40	22.05	20.73	21.51	20.64	19.83	20.04	19.89	20.02	20.78	20.89
10	18.73	18.95	19.45	19.51	20.35	21.22	21.99	22.36	23.50	22.48	21.57	22.33	21.23	20.29	20.30	19.81	19.71	20.10	20.06
11	19.34	19.25	19.09	18.70	19.15	20.04	21.07	21.79	23.24	22.36	21.77	22.84	21.94	20.81	20.70	20.05	19.63	19.75	19.46
12	20.23	19.89	19.47	18.39	18.33	18.95	19.89	20.98	22.45	22.02	21.70	23.22	22.30	21.35	21.17	20.50	19.95	19.71	19.24
13	21.18	21.05	20.12	18.67	18.19	18.33	18.81	19.82	21.51	21.45	21.39	23.05	22.48	21.83	21.82	21.00	20.47	20.15	19.39
14	21.87	22.32	20.91	19.37	18.51	18.30	18.35	18.95	20.39	20.66	20.76	22.80	22.33	22.00	22.29	21.63	21.12	20.73	19.94
15	22.19	23.28	22.06	20.48	19.30	18.59	18.40	18.78	19.64	19.81	20.13	22.29	22.08	21.97	22.48	22.11	21.81	21.47	20.73
16	22.12	23.85	23.06	21.87	20.60	19.48	18.93	18.84	19.45	19.27	19.37	21.68	21.59	21.80	22.39	22.33	22.23	22.17	21.61
17	21.71	23.99	23.47	22.62	21.80	20.77	19.68	19.66	19.47	19.10	18.96	21.08	21.06	21.29	22.10	22.16	22.29	22.52	22.12
18	20.96	23.75	23.42	23.02	22.61	21.84	20.87	20.53	19.81	19.22	18.90	20.69	20.52	20.74	21.64	21.84	22.09	22.56	22.50
19	20.01	23.02	22.84	22.76	22.85	22.61	21.90	21.69	20.56	19.62	19.05	20.63	20.10	20.14	20.91	21.25	21.58	22.22	22.39
20	19.04	21.82	21.75	22.16	22.55	22.64	22.37	22.61	21.46	20.33	19.57	20.66	19.94	19.71	20.34	20.48	20.90	21.56	21.84
21	18.43	20.88	20.70	21.05	21.82	22.34	22.34	23.01	22.14	21.08	20.07	21.02	20.16	19.69	20.05	19.54	20.28	20.80	21.13
22	18.33	20.32	19.62	19.83	20.63	21.61	21.88	22.77	22.22	21.61	20.85	21.49	20.48	19.87	20.07	19.68	19.92	20.02	20.41
23	18.71	19.99	18.93	18.78	19.61	20.50	21.25	22.49	22.14	21.72	21.47	21.98	20.96	20.32	20.29	19.77	19.76	19.45	19.55

DATUM IS .... MSL 20.75 14941.74

Figure 33. Example of NOS tide summary.--Continued

5. Meteorological Observations.

The meteorological instruments are read daily and the data are recorded on CERC Form 78-236 (Fig. 34). Daily monitoring of the instruments facilitates rapid identification of problems with the equipment as well as obtaining climatological information. An example of the daily meteorological observation summaries for 1 month of data from the FRF is shown in Figure 35.

IV. DATA REQUESTS

The Coastal Engineering Information and Analysis Center (CEIAC) is responsible for storing and disseminating most data collected at the FRF under the BEM. All data requests should be in writing and addressed to: Coastal Engineering Research Center, Corps of Engineers, Kingman Building, Fort Belvoir, Virginia 22060. Tidal data other than summaries should be obtained directly from the Tides Branch, National Ocean Survey, Rockville, Maryland 20850. A complete explanation of the exact data desired for specific dates or times will expedite filling any request. The request should also explain how the data will be used to help determine if other relevant data are available. For information regarding the availability of data, contact CEIAC at (202) 325-7386. Costs for collecting, copying, and mailing will be borne by the requestor.

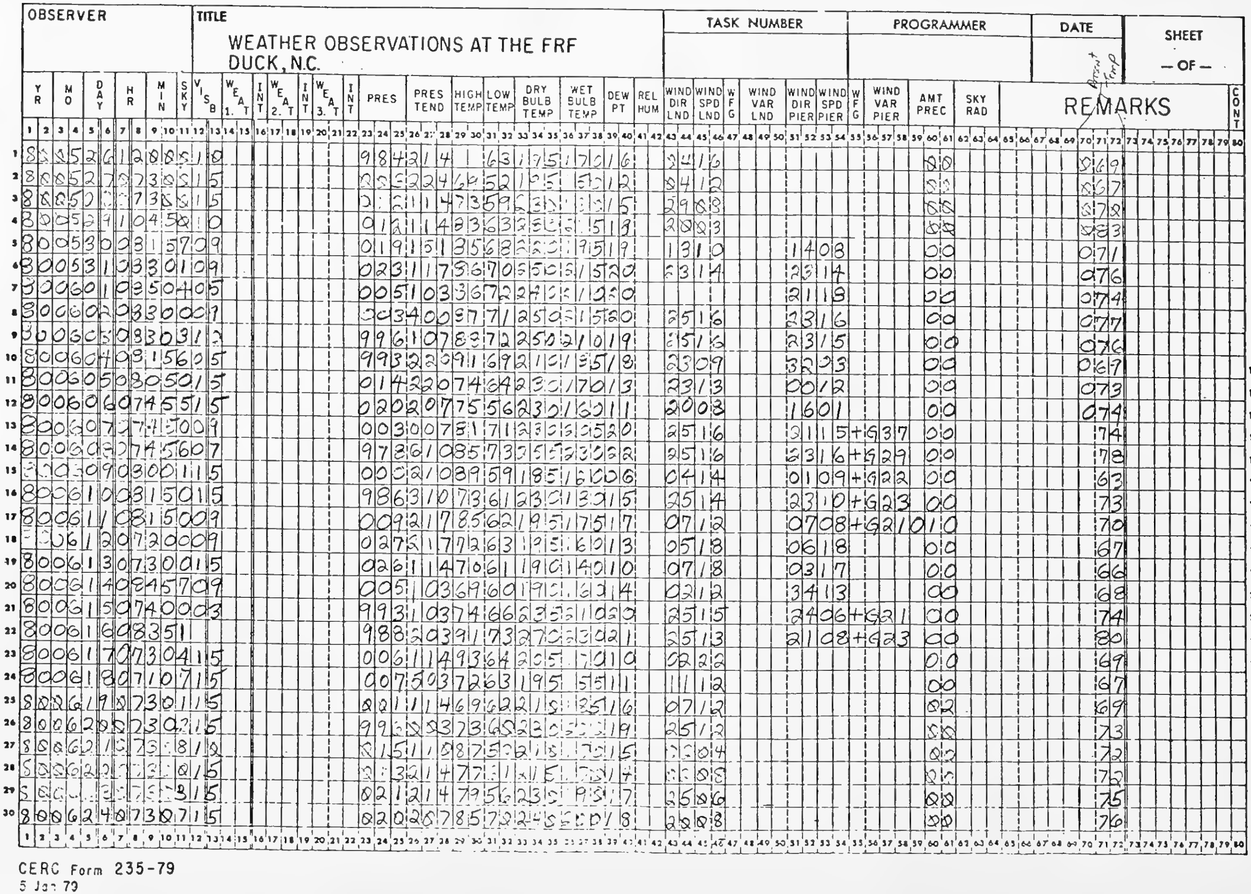

Figure 34. Example of meteorological observations recorded on CERC Form 78-236.

Daily meteorological observations at the Field Research Facility, Duck, N.C.

MONTH 11 YEAR 78

DAY	TIME	CLOUD COVER (8=MAX)	VISIB (MILES)	WEATHER CONDITIONS PREV INT 1	COEXISTING INT 2	INT 3	ATM PRES (INCHES OF HG)	PRE TREND	HIGH TEMP (F)	LOW TEMP (F)	DRY BULB (C)	WET BULB (C)	DEW PT C	REL HUM	LAND WIND DIR DEG	LAND WIND SPEED KNOTS	F G	A R	PIER WIND DIR DEG	PIER WIND SPEED KNOTS	F G	A R	PRECIP INCHES	SKY RAD
1	730	0	5.0	K			30.16	203	0	0	54.0	0.0	0	84	320	7	0	0					0.00	0
2	730	0	9.0	K			30.22	302	0	0	60.0	0.0	0	84	40	9	0	0					0.00	0
3	730	2	9.0	K			30.22	302	0	0	60.0	0.0	0	70	30	10	0	0					0.00	0
4	0	0	0.0				29.89	400	0	0	61.0	0.0	0	86	0	0	0	0					1.40	0
5	0	0	0.0				30.00	206	0	0	58.0	0.0	0	82	0	0	0	0					.80	0
6	735	1	4.0	R			30.16	204	0	0	58.0	0.0	0	86	250	2	0	0					0.00	0
7	735	0	5.0	K			30.06	400	0	0	60.0	0.0	0	86	220	4	0	0					0.00	0
8	730	8	4.0	R			29.90	400	0	0	61.0	0.0	0	86	30	11	0	0					.10	0
9	735	8	4.0	K			30.13	205	0	0	55.0	0.0	0	65	350	6	0	0					.70	0
10	0	0	0.0				30.16	203	0	0	60.0	0.0	0	84	0	0	0	0					0.00	0
11	0	0	0.0				30.21	204	0	0	62.0	0.0	0	87	0	0	0	0					.07	0
12	0	0	0.0				30.24	202	0	0	58.0	0.0	0	87	0	0	0	0					0.00	0
13	745	8	5.0	K-			30.34	206	0	0	59.0	0.0	0	82	60	10	0	0					0.00	0
14	730	0	5.0	R-			30.32	202	0	0	58.0	0.0	0	65	0	0	0	0					0.00	0
15	735	8	5.0	K			30.26	202	0	0	63.0	0.0	0	66	220	4	0	0					0.00	0
16	740	7	5.0	K			30.28	202	0	0	63.0	0.0	0	65	220	3	0	0					0.00	0
17	735	6	4.0	K			30.35	500	0	0	63.0	0.0	0	88	100	8	0	0					0.00	0
18	0	0	0.0				30.14	101	0	0	70.0	0.0	0	63	0	0	0	0					0.00	0
19	0	0	0.0				30.29	304	0	0	56.0	0.0	0	78	0	0	0	0					0.00	0
20	740	8	4.0				30.45	304	0	0	55.0	0.0	0	78	40	10	0	0					0.00	0
21	735	2	9.0				30.36	400	0	0	59.0	0.0	0	65	40	10	0	0					0.00	0
22	730	4	5.0				30.28	202	0	0	56.0	0.0	0	65	30	11	0	0					0.00	0
23	0	0	0.0				30.23	701	0	0	57.0	0.0	0	82	0	0	0	0					.10	0
24	740	6	3.0	K			29.76	501	0	0	56.0	0.0	0	87	270	8	0	0					.30	0
25	0	0	0.0				29.98	205	0	0	43.0	0.0	0	72	0	0	0	0					0.00	0
26	0	0	0.0				30.14	103	0	0	40.0	0.0	0	72	0	0	0	0					0.00	0
27	730	8	5.0				30.10	603	0	0	54.0	0.0	0	84	150	12	0	0					0.00	0
28	740	8	4.0	K			30.01	102	0	0	55.0	0.0	0	86	180	6	0	0					.47	0
29	730	8	4.0	R			30.30	102	0	0	54.0	0.0	0	80	70	8	0	0					0.00	0
30	745	8	4.0	K-			30.02	104	0	0	49.0	0.0	0	88	280	6	0	0					1.10	0

KEYNOTES ON WEATHER OBSERVATIONS

WEATHER CONDITIONS

- WS WATER SPOUT
- TH THUNDERSTORM
- FD FREEZING DRIZZLE
- F FOG
- SS SNOW SHOWER
- RS RAIN SHOWER
- H HAIL
- S SNOW
- R RAIN
- D DRIZZLE
- K HAZE OR SMOKE

INTENSITY OF WEATHER CONDITIONS

- (+) UNUSUALLY INTENSE
- (-) MILD CONDITIONS

PRESSURE TREND

FIRST NUMBER INDICATES CHARACTERISTIC OF CHANGE

- 0 = INCREASING THEN DECREASING
- 1 = INCREASING THEN STEADY OR INCREASING MORE SLOWLY
- 2 = INCREASING EITHER STEADY OR UNSTEADY
- 3 = DECREASING OR STEADY THEN INCREASING OR INCREASING THEN INCREASING MORE RAPIDLY.
- 4 = STEADY
- 5 = DECREASING THEN INCREASING
- 6 = DECREASING THEN STEADY OR DECREASING MORE SLOWLY
- 7 = DECREASING STEADY OR UNSTEADY
- 8 = STEADY OR INCREASING THEN DECREASING OR DECREASING THEN DECREASING MORE SLOWLY

NEXT TWO COLUMNS INDICATE CODE OF THE AMOUNT OF CHANGE IN LAST THREE HOURS, HIGHER NUMBERS INDICATE MORE CHANGE, I.E.

- 00=0.0 INCHES HG =0.0 MILLIBARS
- 51=0.150 INCHES OF HG =5.1 MILLIBARS
- 100=0.295 INCHES OF HG =10.0 MILLIBARS
- 200=0.590 INCHES OF HG =20.0 MILLIBARS

W F G

A (+) SYMBOL IS ENTERED IF THE WIND SPEED VARIES BY MORE THAN 10 KNOTS.

V A R

A (G) AND THE PEAK VALUE ARE ENTERED UNDER (VAR) WHEN THE PEAK VALUE OF THE WIND EXCEEDS THE VALUE OF THE WIND SPEED BY 10 KNOTS

Figure 35. Example of daily meteorological observation summaries.

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APPENDIX

INSTRUMENT INSTALLATION CHART

Sensor No.	Sensor type	Data type	Location	Medium depth (MSL) at sensor (ft)	Sensor range (ft)	Initial installation (date)
615	Baylor staff continuous wire	Wave	Station 620 FRF pier	7.5	28	23 Nov. 1977
625	Baylor staff continuous wire	Wave	Station 1900 FRF pier	27	31	11 Nov. 1977
112	Baylor staff continuous wire	Wave	Jennette's Fishing Pier, Nags Head, N.C.	17	25	Nov. 1977
610	Waverider buoy	Wave	350 ft NE. of seaward end of FRF pier	23	32	25 July 1978
620	Waverider buoy	Wave	1.3 mi. E. of seaward end of FRF pier	60	32	25 July 1978
611	Pressure gage	Wave	Station 1940 FRF pier	27	25	23 Nov. 1977
619, 629 (channels X and Y respectively)	Electromagnetic current meter	Mean and wave-induced bottom currents	Station 1940 FRF pier	27	±10 ft/s	19 Nov. 1977
639, 649 (channels X and Y respectively)	Electromagnetic current meter	Mean and wave-induced bottom currents	500 ft N. of FRF pier at approximately Station 1940	21	±10 ft/s	19 Nov. 1977
612	Temperature probe	Water temperature	9.6 ft below MSL at station 1960, FRF pier	27		20 Nov. 1977
613	Conductivity probe	Conductivity of seawater	9.6 ft below MSL at station 1960, FRF pier	27		20 Nov. 1977
602	Temperature probe	Water temperature	22 ft below MSL at station 1960, FRF pier	27		20 Nov. 1977
603	Conductivity probe	Conductivity of seawater	22 ft below MSL at station 1960, FRF pier	27		20 Nov. 1977
865-1370	Leupold-Stevens float-activated tide gage	Water level information	FRF pier end at station 1960	27		14 Jan. 1979
865-1371	Fischer-Porter float-activated gage	Water level information	FRF pier at station 720	11		17 Dec. 1977
	Bubbler (pressure) tide gage	Water level information	1,000 ft W. of shore in Currituck Sound at FRF	5		28 Oct. 1977
	Fischer-Porter float-activated tide gage	Water level information	1,000 ft W. of shore in Currituck Sound at FRF	5		28 Oct. 1977

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Sensor No.	Sensor type	Data type	Location	Medium depth (MSL) at sensor (ft)	Sensor range (ft)	Initial installation (date)
865-1376	Metercraft pressure tide gage	Water level information	1,000 ft W. of shore in Currituck Sound at FRF	4		15 July 1978
	Anemometer	Wind speed and direction	190 ft behind the dune			25 Feb. 1978
	Microbarograph	Continuously records the atmospheric pressure	Inside office trailer			4 Mar. 1978
	Barometer	Atmospheric pressure	Inside office trailer			4 Mar. 1978
	Hygrothermograph	Continuously records the air temperature and relative humidity	Located in the instrument shack, 300 ft from dune			4 Mar. 1978
	Maximum thermometer	Maximum air temperature	Instrument shelter			4 Mar. 1978
	Minimum thermometer	Minimum air temperature	Instrument shelter			4 Mar. 1978
	12-inch weighing rain gage	Continuously records the amount of precipitation	285 ft behind the dune			4 Mar. 1978
	6-inch rain gage	Precipitation	270 ft behind the dune			4 Mar. 1978
	Sling psychrometer	Dew point	Used at instrument shelter			11 Dec. 1978
	Mechanical pyranograph	Solar radiation	Mounted on top of instrument shelter			18 Jan. 1979

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[42] p. : ill. : 27 cm. -- (Miscellaneous report -- U.S. Coastal Engineering Research Center ; no. 80-8)
Includes bibliographical references.
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