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Movable-Bed Laboratory Experiments Comparing Radiation Stress and Energy Flux Factor as Predictors of Longshore Transport Rate

by

Philip Vitale

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The results of three-dimensional movable-bed laboratory tests are used to empirically relate the longshore sediment transport rate to the radiation stress and the longshore energy flux factor. Both correlate equally well with the longshore transport rate, producing correlation coefficient squared values of approximately 0.70. The surf similarity parameter also shows a strong influence on the longshore transport rate.

PREFACE

This report is published to provide coastal engineers insight into the important coastal process of longshore transport along sandy beaches by presenting the results of three-dimensional movable-bed laboratory tests. It is hoped that future studies will expand on the analyses of the data in this report. The report was prepared under the nearshore sediment transport research program of the U.S. Army Coastal Engineering Research Center (CERC).

The report was written by Philip Vitale, Hydraulic Engineer, under the general supervision of Dr. R.M. Sorensen, Chief, Coastal Processes and Structures Branch, Research Division.

The author acknowledges C. Galvin, R.P. Savage, and R.P. Stafford for their assistance and advice in the design and operation of the experiment, and M.S. Bartolomei, S.L. Douglas, B. Keely, M. Koenig, M.W. Leffler, J.G. Tingler, J. Sullivan, K.P. Zirkle, and, in particular, L.O. Tornese for their help in collecting and analyzing the data.

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

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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.

SYMBOLS AND DEFINITIONS

a'	ratio of sand volume to total volume of a sand deposit
b	subscript for breaker
C	wave phase velocity
C_g	wave group velocity
d	water depth
d_{50}	median sand size
$\overline{E}$	energy density
F_x	flux of wave energy per alongshore distance
g	acceleration of gravity
H	wave height
$\overline{H}$	average wave height
H_{rms}	root-mean-square wave height
H_s	significant wave height
I_ℓ	longshore transport rate in immersed weight per unit time
i	subscript for any point seaward of breaker zone
K_p	empirical coefficient relating I_ℓ to $P_{\ell b}$
K_s	empirical coefficient relation I_ℓ to S_{xy}
k	wave number = $2\pi/L$
L	wavelength
n	ratio of C_g to C
o	subscript for deepwater condition
P_ℓ	energy flux term
$P_{\ell b}$	longshore energy flux factor as used in this report
$P_{\ell s}$	longshore energy flux factor as used in the SPM
Q	longshore transport rate in volume per unit time
R	range of coordinate system defined in Figure 7

r	correlation coefficient
S	station of coordinate system defined in Figure 7
S_{xy}	radiation stress component (flux of y-momentum in x-direction)
T	wave period
t	time
u	onshore component of water particle velocity
v	alongshore component of water particle velocity
x	coordinate in onshore direction
y	coordinate in alongshore direction
z	coordinate in vertical direction
α	angle between wave crest and shoreline
α_g	angle between wave generator and shoreline
β	angle of beach slope with horizontal
η	water surface elevation
θ	wave phase
ξ	surf similarity parameter as used in this report
ξ_b	surf similarity parameter as used in Kamphuis and Readshaw (1978)
ρ	mass density of water
ρ_s	mass density of sand
ω	angular frequency of wave = $2\pi/T$

MOVABLE-BED LABORATORY EXPERIMENTS COMPARING RADIATION STRESS AND ENERGY FLUX FACTOR AS PREDICTORS OF LONGSHORE TRANSPORT RATE

by
Philip Vitale

I. INTRODUCTION

Three-dimensional movable-bed laboratory tests were conducted to compare radiation stress and energy flux factor as predictors of the longshore sediment transport rate. The tests were performed in the U.S. Army Coastal Engineering Research Center's (CERC) Shore Processes Test Basin (SPTB). This report presents derivations of the radiation stress and the energy flux factor, documents the experimental setup and procedure, tabulates most of the data, and performs the data analyses. Many photos were taken during the tests; however, only a few were used in the report. The complete set of test photos is available from CERC's Coastal Engineering Information and Analysis Center (CEIAC).

II. EMPIRICAL RELATIONS

The longshore transport data are related empirically to the two expressions representing wave conditions. One, radiation stress, is based on momentum flux, the other on energy flux. An important concept which is also used in the data analyses is the surf similarity parameter.

1. Momentum Flux.

The dependent variable studied here is the longshore transport rate caused by waves approaching the beach; therefore, the consequential momentum term is the onshore flux of alongshore momentum. The derivation of the term follows Longuet-Higgins (1970) which applies the concept of wave momentum flux to the generation of longshore currents.

The coordinate system used is shown in Figure 1. The y-axis is along the shoreline, the x-axis is normal to the shoreline and positive shoreward, and the z-axis originates at the stillwater level and is positive upward. Using this system, the onshore flux of alongshore momentum is the flux of y-momentum in the x-direction, S_{xy}. This term is one component of what is commonly called the radiation stress tensor.

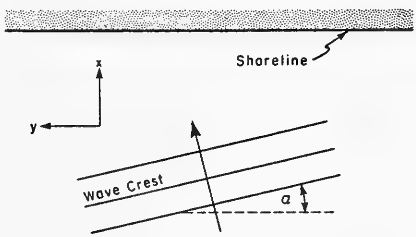

Figure 1. Coordinate system for momentum flux derivation.

According to small-amplitude wave theory, the components of the water particle velocity in the x- and y-directions for a wave traveling at an angle, α, to the shoreline (Fig. 1) are, respectively,

$$u = \frac{H}{2}\frac{gT}{L}\frac{\cosh\,[k(z + d)]}{\cosh\,kd}\cos\theta\,\cos\alpha \tag{1}$$

$$v = \frac{H}{2}\frac{gT}{L}\frac{\cosh\,[k(z + d)]}{\cosh\,kd}\cos\theta\,\sin\alpha \tag{2}$$

where

H = wave height

g = acceleration of gravity

T = wave period

L = wavelength

d = water depth

k = wave number

θ = wave phase.

The last two terms are defined as

$$k = \frac{2\pi}{L}$$

and

$$\theta = kx - \omega t$$

where t is time, and ω the wave angular frequency

$$\omega = \frac{2\pi}{T}$$

The y-momentum (alongshore momentum) per unit volume is ρv where ρ is the water mass density. The flux of this momentum in the x-direction (onshore) per unit alongshore distance and unit water depth is ρvu. Integrating over the water column and averaging over time produce the mean alongshore momentum flux in the x-direction per unit alongshore distance

$$S_{xy} = \overline{\int_{-d}^{\eta} \rho vu\,dz} \tag{3}$$

where the overbar denotes the mean with respect to time and η the water surface elevation. Substituting equations (1) and (2) into (3) and dropping terms of higher than second order produce

$$S_{xy} = (\overline{E}C_g\,\cos\alpha)\,\frac{\sin\alpha}{C} \tag{4}$$

where C is the wave phase velocity, C_g the wave group velocity, and $\overline{E}$ the wave energy density

$$\overline{E} = \frac{\rho g H_{rms}^2}{8} \tag{5}$$

where H_{rms} is the root-mean-square (rms) wave height. The term in parentheses in equation (4) is the flux of wave energy per alongshore distance, F_x, assuming straight and parallel bathymetric contours. When zero wave energy dissipation is assumed,

$$F_x = \overline{E}C_g \cos\alpha = \text{constant} \tag{6}$$

In this report, dissipation is assumed to be zero up to the breaker zone; therefore, F_x is constant from deep water to the breaker zone. Since the ratio of $\sin\alpha$ to C is constant due to Snell's law, equation (4), which represents the alongshore wave momentum entering the surf zone, is constant seaward of the breaker zone.

Equation (4) can be revised for application of monochromatic waves, as in this report. For such wave conditions, the average wave height, $\overline{H}$, measured during the tests (and discussed later in Section IV) is equal to H_{rms}. By rewriting equation (4),

$$S_{xy} = \left(\frac{\rho g \overline{H}^2}{8} C_g \cos\alpha\right) \frac{\sin\alpha}{C} \tag{7}$$

S_{xy} is now defined for use with laboratory monochromatic wave data. Note that equation (4) is valid for any wave condition; equation (7) is valid only for conditions where $\overline{H}$ equals H_{rms}.

2. Energy Flux.

In literature, the longshore transport rate has been empirically related most frequently to a term found by multiplying both sides of equation (4) by the wave phase velocity, C, to yield

$$P_\ell = (\overline{E}C_g \cos\alpha) \sin\alpha \tag{8}$$

Unlike S_{xy}, P_ℓ is not constant seaward of the breaker line; therefore, specifying where P_ℓ is being calculated is necessary. This report, following convention, determines P_ℓ at the breaker line,

$$P_{\ell b} = (\overline{E}C_g \cos\alpha)_b \sin\alpha_b \tag{9}$$

representing the value of P_ℓ at the point closest to where the longshore transport is occurring. The subscript b denotes breaker values. The term in parentheses in equation (9) has been shown to be constant (see eq. 6) seaward of the breaker line; therefore, subscript b may be replaced by i which represents any point seaward of the breaker line. Making this change, using equation (5), and letting H_{rms} equal $\overline{H}$ for monochromatic waves, equation (9) becomes

$$P_{\ell b} = \left(\frac{\rho g \overline{H}^2}{8} C_g \cos\alpha\right)_i \sin\alpha_b \tag{10}$$

The Shore Protection Manual (SPM) (U.S. Army, Corps of Engineers, Coastal Engineering Research Center, 1977) provides a term similar to $P_{\ell b}$ except that the wave height used is the significant height, H_s. The term, called the longshore energy flux factor, is defined as

$$P_{\ell s} = \left(\frac{\rho g H_s^2}{8} C_g \cos\alpha \sin\alpha\right)_b \tag{11}$$

$P_{\ell s}$ is derived in Galvin and Schweppe (1980). The relationship between H_{rms} and H_s has been shown in Longuet-Higgins (1952) to be

$$H_s^2 = 2H_{rms}^2 \tag{12}$$

assuming a Rayleigh distribution of wave heights as well as a number of other conditions. Therefore,

$$P_{\ell b} = \frac{P_{\ell s}}{2} \tag{13}$$

Since $P_{\ell b}$ and $P_{\ell s}$ are essentially the same terms, this report uses the SPM terminology and refers to $P_{\ell b}$ as the longshore energy flux factor.

3. Longshore Transport Rate.

The longshore transport rate, Q, given in the SPM in units of volume per unit time, is also commonly shown as I_ℓ with units of immersed weight per unit time. The relationship between the two is

$$I_\ell = (\rho_s - \rho)\, g a'\, Q \tag{14}$$

where ρ_s is the mass density of sand and a' the ratio of sand volume to total volume of a sand deposit, which takes into account the sand porosity. For discussions of equation (14), see Komar and Inman (1970) and Galvin (1979). Since the laboratory tests described here measured I_ℓ directly, this term is used in most of the data analysis.

4. Empirical Relations.

The expressions derived in the preceding paragraphs are used to set up the following empirical relations

$$I_\ell = K_p P_{\ell b} \tag{15}$$

and

$$I_\ell = K_s S_{xy} \tag{16}$$

where K_p and K_s are coefficients to be determined from the test data in this report.

Equation (15) is based on the concept that the work done in moving the sand alongshore is proportional to the energy which approaches the beach. The units are consistent and K_p is dimensionless.

Equation (16) is based on the concept that the sand transported alongshore depends on the alongshore force exerted by the wave motion on the bed inside the surf zone. By the equation of motion, this force is related to the change of momentum inside the surf zone. The alongshore momentum, S_{xy}, enters the surf zone through the breaker line but cannot exit through the shoreline boundary. Therefore, the change in alongshore momentum is S_{xy} and equation (16) results. K_s has dimensions of length over time.

5. Surf Similarity Parameter.

Kamphuis and Readshaw (1978) showed that K_p and K_s are dependent upon the surf similarity parameter,

$$\xi_b = \frac{\tan \beta}{(H_b/L_o)^{1/2}} \tag{17}$$

in which $\tan \beta$ is the beach slope, H_b the breaker height, and L_o the deepwater $(d/L > 1/2)$ wavelength. ξ_b reflects variations in beach shape, breaker type, and rate of energy dissipation. Using the results of laboratory tests, the following relationships were found by Kamphuis and Readshaw

$$K_p \approx 0.7\xi_b \quad \text{for} \quad 0.4 < \xi_b < 1.4 \tag{18}$$

$$K_s \approx 0.08\xi_b \quad \text{for} \quad 0.4 < \xi_b < 1.25 \tag{19}$$

For values of ξ_b higher than the upper limits, K_p and K_s become independent of ξ_b.

The surf similarity parameter is evaluated in this report to determine its effect on the longshore transport rate.

III. EXPERIMENTAL SETUP

This section discusses the setup in the SPTB (Figs. 2 and 3) and describes the wave generators, wave gages, and cameras and their positions. Also discussed are the sand-moving system, the method for measuring the longshore current velocity, and the size distribution of the sand used in the experiment. The design of the setup was based in large part on Fairchild (1970).

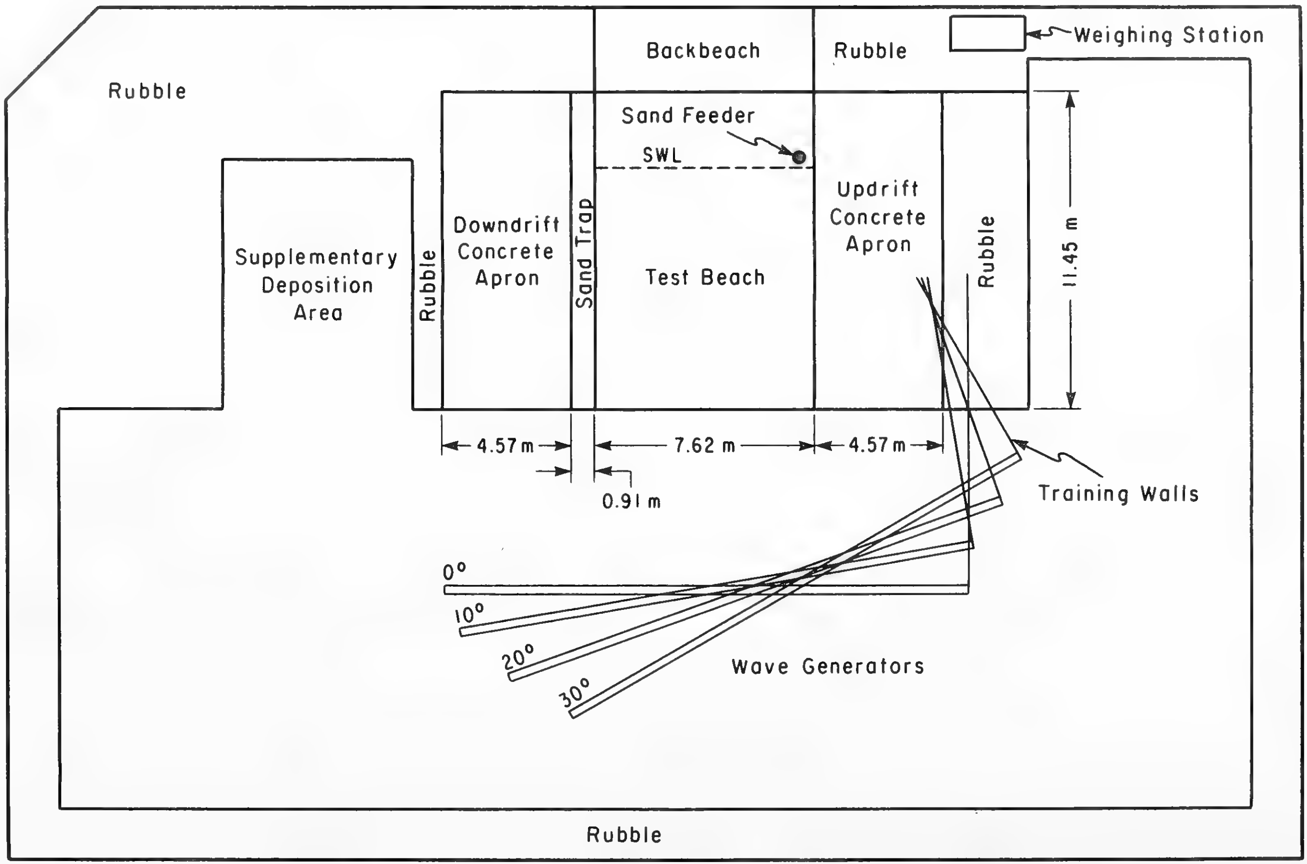

Figure 2. Diagram of test basin setup.

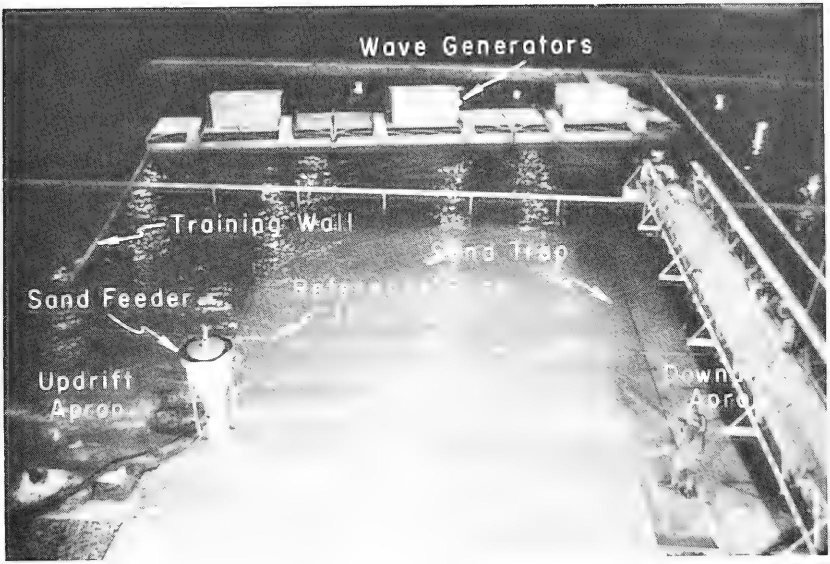

Figure 3. Photo of test basin setup.

1. <u>Basin Layout</u>.

A diagram of the basin setup is shown in Figure 2. The basin is 45.72 meters long, 30.48 meters wide, and 1.22 meters deep. The alongshore and the shore-normal directions of the sand beach were 7.62 and 11.45 meters, respectively. The backbeach was 3.05 meters in the shore-normal direction, but it was not part of the test beach.

Immediately downdrift of the beach was the sand trap, 0.91 meter wide and 12.7 centimeters deep (Fig. 4), used to catch the longshore transport.

Concrete aprons, 4.57 meters in the alongshore direction, were located on the downdrift side of the sand trap and on the updrift side of the beach. The updrift apron provided enough distance for the longshore current to develop between the updrift training wall and the beach. This phenomenon is discussed in Galvin and Eagleson (1965). The downdrift apron served two purposes--one as a platform for depositing the longshore transport that escaped the trap, the other as a surface on which the waves traveled to diminish diffraction effects since no downdrift training walls were used.

The major limitation in the experimental planning was the size of the SPTB, which permitted three wave generators, each 6.10 meters long, to be linked together and leave enough room to be rotated through various angles to the beach. The other limitation was the decision not to use downdrift training walls due to the wave reflection problem. When downdrift training walls are used, the wave energy, which is reflected off the beach at an angle in the downdrift direction, strikes the downdrift wall and is reflected back toward the updrift direction. The energy is then reflected by the updrift wall and the process repeats. The reflected wave energy is being trapped within the

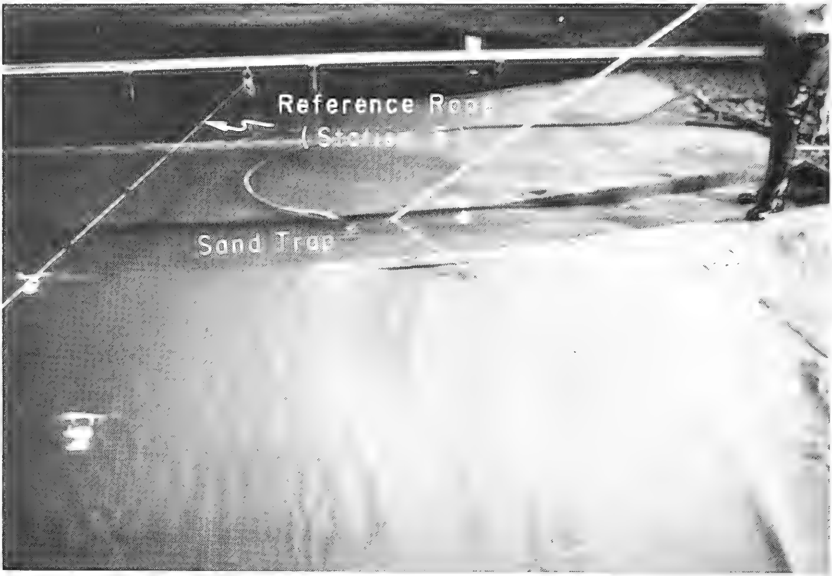

Figure 4. Photo of sand trap.

two walls; this produces some complicated wave variability problems (e.g., see Fairchild, 1970). With no downdrift training walls, the reflected wave energy moves away from the beach area into the outer parts of the test basin where most of it is eventually dissipated by the rubble slope along the edge of the basin (Fig. 2). This, however, creates a problem with wave diffraction. The energy of the wave leaving the generator spreads laterally into still water and gradually decreases the wave height toward the updrift end of the wave crest.

To minimize the decrease in wave height over the test beach, it was designed using the diffraction diagram for a wave traveling past a semi-infinite breakwater from Figure 2-33 of the SPM. The period and angle used in the diffraction analysis were 3 seconds and 10°, respectively, since these values produced the maximum diffraction closest to the beach. The spreading of wave energy into the shadow of a breakwater is analogous to the spreading of wave energy into the area of the test basin downdrift of the generators. The diagram (Fig. 5) indicated that the alongshore length of the beach should be 7.62 meters. Most of the diffraction-caused decrease in wave height occurs over the downdrift concrete apron.

Rubble, ranging in size from 7.62 to 15.24 centimeters, was placed at several locations in the basin to absorb wave energy and provide gradual slopes between the concrete aprons and the basin floor. The beach, sand traps, concrete aprons, and adjacent rubble were all built to the same shore-normal profile (Fig. 6). This profile was based on Chesnutt's (1978) long-term two-dimensional tests in which waves were run onto a sand beach to determine profile response. After superposing several of Chesnutt's (1978)

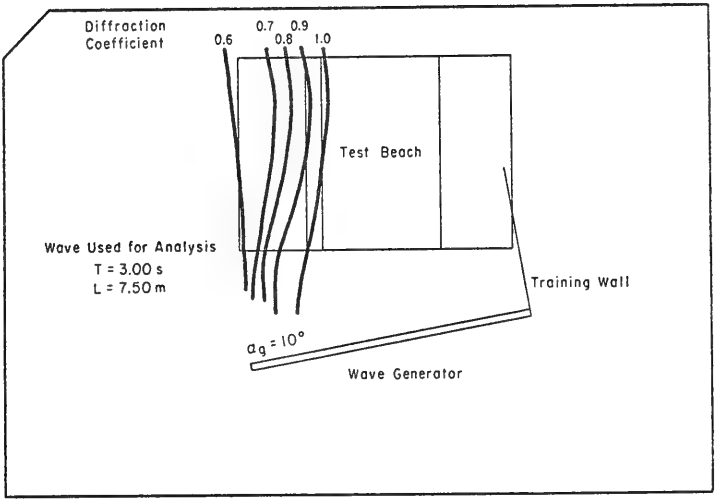

Figure 5. Diagram of diffraction analysis used to determine the alongshore length of the test beach.

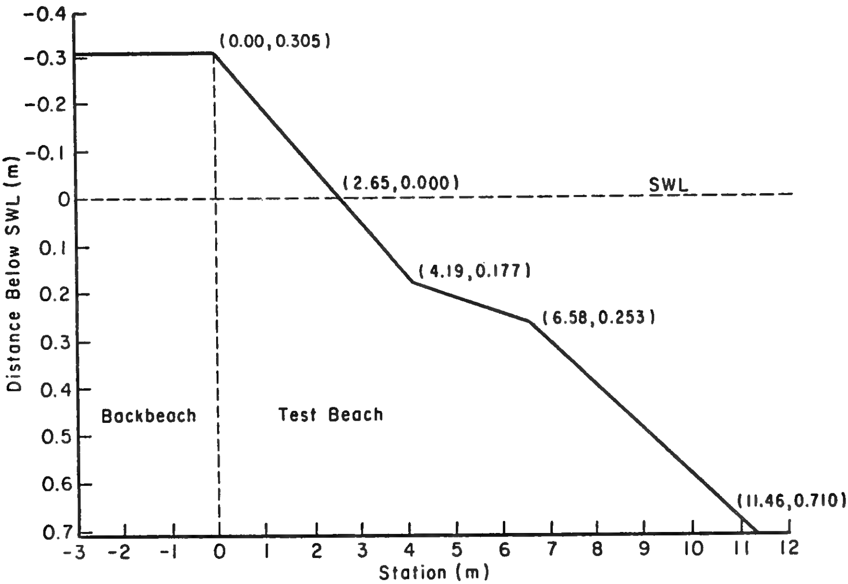

Figure 6. Shore-normal profile of the test beach, sand trap, concrete aprons, and adjacent rubble.

profiles run for 80 hours or more with wave periods similar to those used in this experiment, the shore-normal profile in Figure 6 was drawn as a compromise or average through the superposed profiles. This profile was used to lessen the onshore-offshore adjustment of the beach.

Figure 7 shows the coordinate system used for the test beach. The origin is at the updrift, shoreward corner of the beach. Ranges (in meters) are along the alongshore axis, and stations (in meters) along the shore-normal axis. Any point on the beach, or in the basin, can be described by a range-station pair.

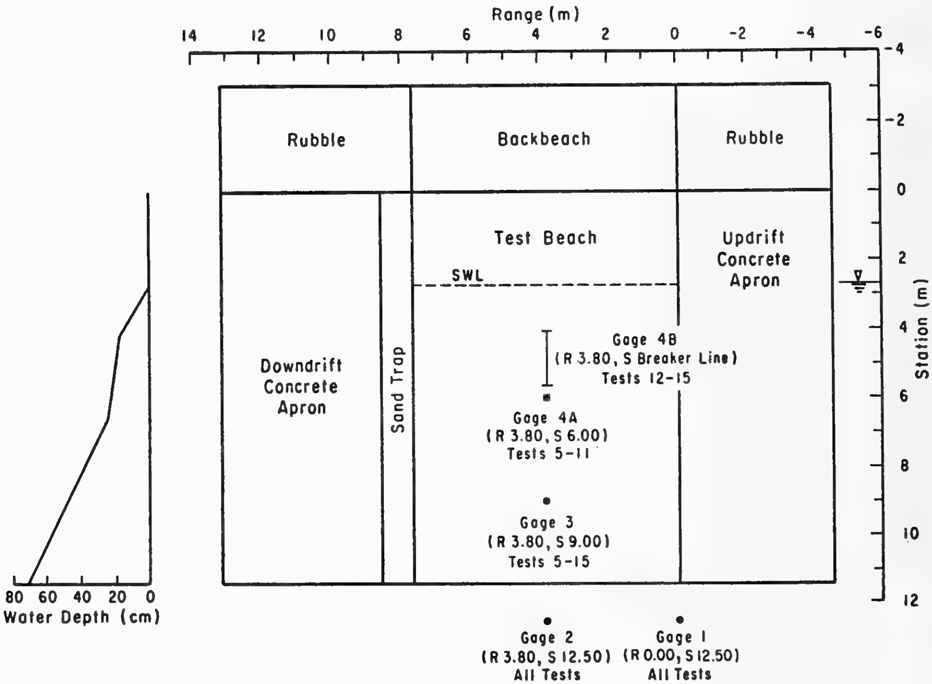

Figure 7. Coordinate system used for test beach with locations of wave gages (R = range, S = station).

2. Generators.

The three piston-type 6.10 meter-long generators used in this experiment produced only monochromatic waves and are discussed in Stafford and Chesnutt (1977). The generators were set at four different angles--0°, 10°, 20°, and 30°--to the beach during the experiment. For each setting, an updrift training wall was built from the generator to the 1-foot depth. This allowed circulation past the wall to feed the longshore current. Figure 2 shows the setup of the four generators and training wall.

For the 10° and 20° tests, the training wall was curved to allow for wave refraction. However, since the wall stopped at the 1-foot depth, the curves were small and considered not worth the construction effort. Therefore, the curve for the 30° tests was deleted and a straight training wall was used.

3. Sand-Moving System.

As the waves approached the beach at an angle, the sand moved in the downdrift direction. Most of it deposited in the sand trap. The sand which escaped the trap deposited either on the downdrift concrete apron or beyond the apron and rubble (covered to keep sand from being lost within it) onto the basin floor. This area is shown in Figure 2 as the supplementary deposition area. Although separate measurements of the sand deposited in each area were not taken, it is estimated that 80 to 95 percent of the longshore transport fell into the trap. The greater the transport rate and the suspended sediment, the greater was the amount of sand escaping the sand trap.

The trap was cleaned continually during a test using an eductor attached to a small centrifugal pump. Water was pumped through the eductor at high speed, creating a suction to pick up the sand (Fig. 8). The sand was pumped to the weighing station (Fig. 9), deposited in one of two bins, and weighed submerged. When divided by the appropriate time period, the value became the immersed weight longshore transport rate.

After the weighing, the sand was pumped, using another eductor, into a sand feeder. The sand feeder is a vertical cylinder open at both ends in which sand is introduced through the top and removed by waves through the bottom. A diagram and a photo of the feeder are given in Figures 10 and 11. The primary advantage of the feeder is that it permits waves to control the amount of sand introduced onto the beach. Savage (1961) discusses the feeder and its development.

In summary, the complete sand-moving system (Fig. 12) included the following:

(a) A sand trap, a downdrift concrete apron, and a downdrift deposition area which trapped the sand;

(b) a downdrift eductor-pump combination which moved the trapped sand to the weighing station;

(c) a weighing station which weighed the amount of sand moved;

(d) an updrift eductor-pump combination which moved the sand from the weighing station to the sand feeder; and

(e) a sand feeder which redeposited the sand onto the beach.

4. Instruments.

Wave heights were measured using parallel-wire wave gages (see Fig. 7). Gages 1 and 2, located seaward of the toe of the beach, were used for all 15 tests. Gage 3, located over the beach, was used for tests 5 to 15. Gage 4A, located close to the breaker line, was used for tests 5 to 11. Beginning with test 12 for the remainder of the tests, gage 4A was adjusted to measure the breaker height and then renamed gage 4B.

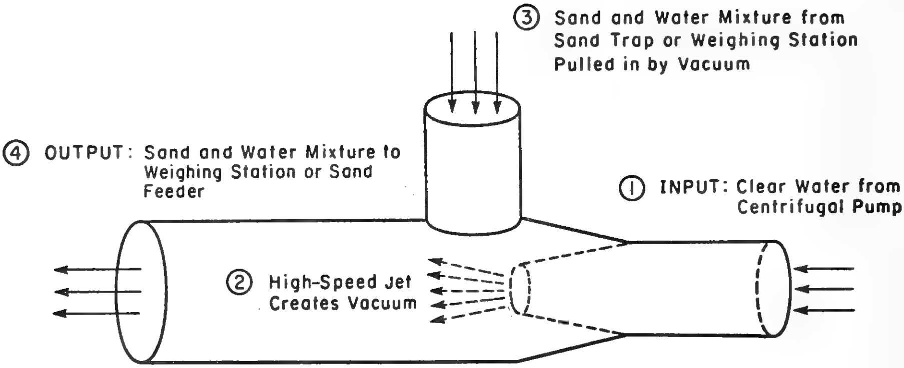

Figure 8. Diagram of eductor.

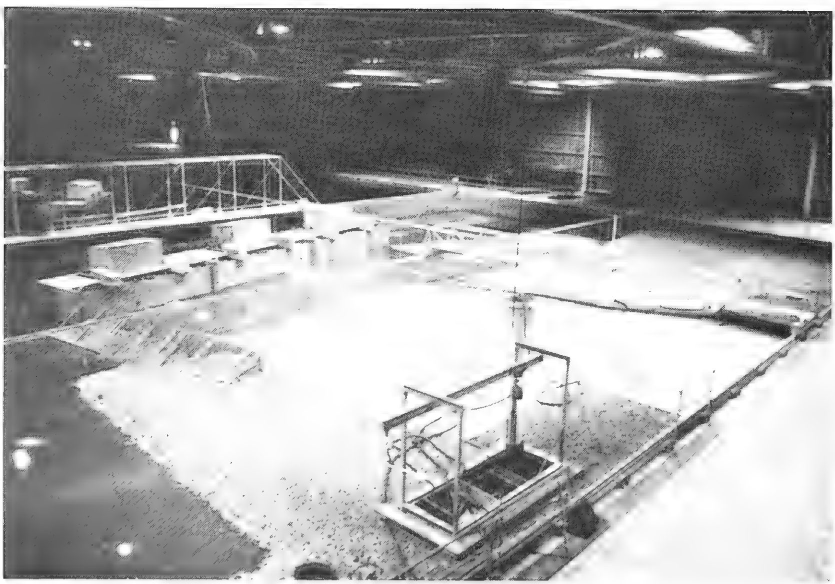

Figure 9. Photo of weighing station.

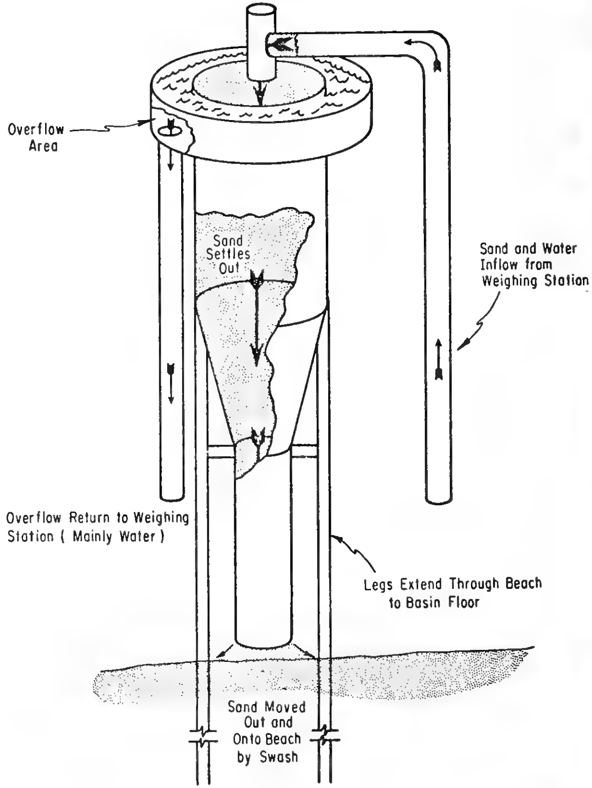

Figure 10. Diagram of sand feeder.

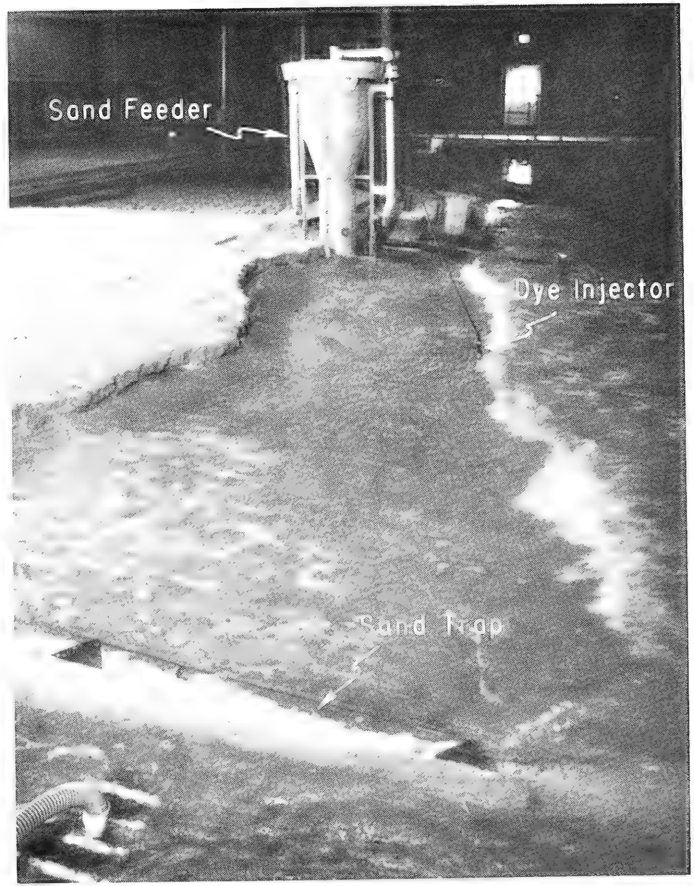

Figure 11. Photo of sand feeder.

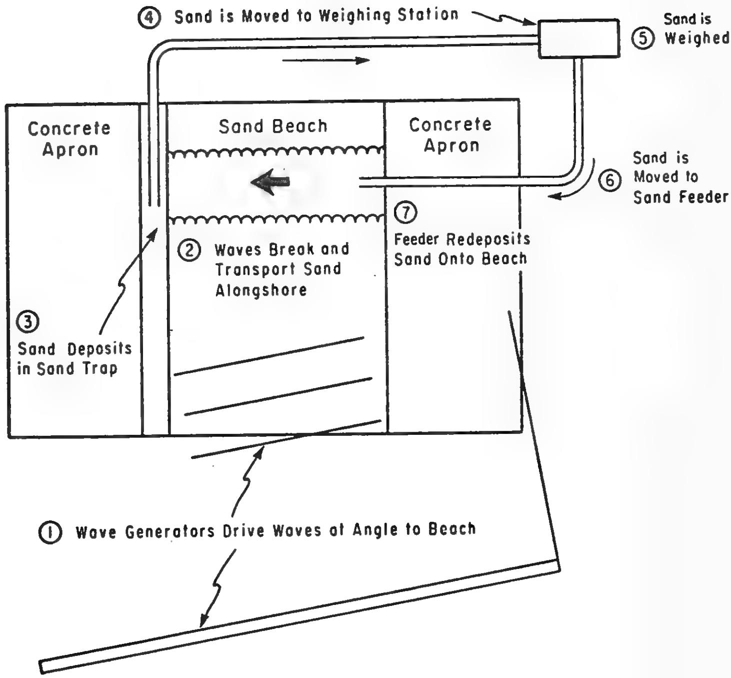

Figure 12. Diagram of complete sand-moving system.

Two cameras were mounted over the beach on the catwalk of the SPTB. One was a view camera with an adapter for taking 4- by 5-inch Polaroid black-and-white photos, and the other a standard 35-millimeter camera. The locations of the cameras are given in Table 1.

Other instruments used in the tests include standard hydraulic scales for weighing the sand, and a standard level and rod for surveying the beach after each test.

Table 1. Locations of overhead cameras mounted on the catwalk.

Location[1]	Camera	
	View (m)	35-mm (m)
Range	3.9	3.9
Station	4.9	4.7
Elevation above SWL	8.5	8.5

[1]Accurate only to ± 0.1 meter.

5. Dye Injection.

Longshore current velocities for tests 5 to 15 were measured by injecting dye into the surf zone through a hose which ran from the sand feeder to a small stake in the surf zone. Dye was poured by hand into the top of the hose. Table 2 gives the locations of the dye injection by test numbers. The change in location of the stake in tests 7 to 10 was a procedural error and not planned for a special purpose. The dye injection procedure is discussed in detail in the next section.

Table 2. Locations of dye injection by test number.

Test Nos.	Dye injected at range (m)	Dye timed from range (m)	Dye timed to range (m)	Timed distance traveled (m)
5 and 6	3.00	3.60	7.60	4.00
7 to 10	3.82	3.82	7.73	3.78
11 to 15	3.00	3.73	7.73	4.00

6. Sand Size.

Figure 13 shows the size distribution of the sand used for all 15 tests. The median diameter was 0.22 millimeter. The geometric standard deviation is defined as

$$\sigma_g = \frac{d_{16}^{1/2}}{d_{84}} \qquad (20)$$

where d_{16} and d_{84} are the sand sizes at which 16 and 84 percent, respectively, of the sample is coarser. The value of σ_g for the sand used was 1.22. Figure 13 indicates that the sand was well sorted.

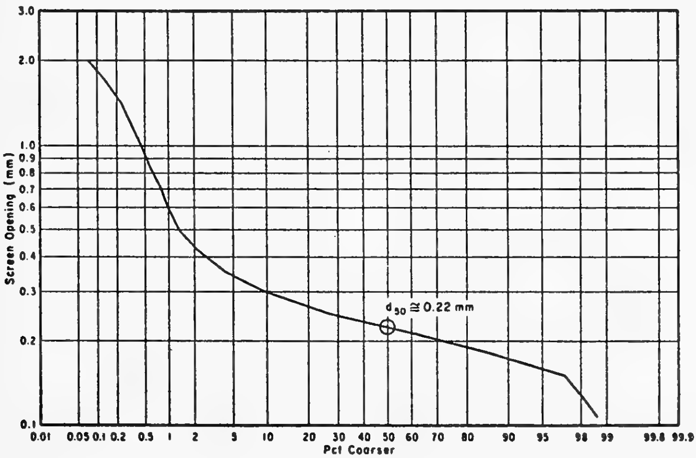

Figure 13. Size distribution of sand used for all tests.

IV. EXPERIMENTAL PROCEDURE

Each test was composed of three major data collection cycles: an hourly cycle, a daily cycle, and a test cycle. For example, wave heights were measured every hour (hourly cycle), water temperature was measured twice a day (daily cycle), and beach surveys were taken at the end of each test (test cycle). The typical test schedule was 4 hourly cycles daily for 6 days for a total of 24 run-hours per test. Tests 1 and 2, as discussed later, were exceptions to this schedule. Figure 14 is a schematic diagram of the interrelationship of the three cycles. Since waves were run every other day, a complete test took about 3 weeks.

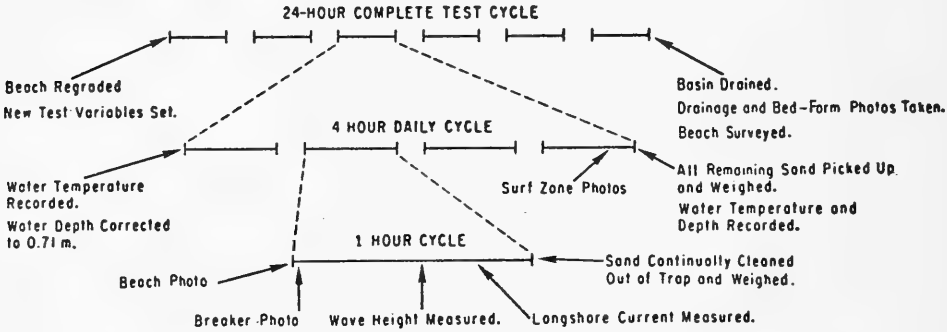

Figure 14. Schematic diagram of the interrelationship of the three experimental cycles.

1. Hourly Cycle.

The various types of data collected in a typical hourly cycle are shown in Figure 14, along with an indication of time of collection. Before a new hour of run-time was started, photos of the beach were taken from overhead with both the 35-millimeter camera (Fig. 15) and the view camera. A reference rope in the alongshore direction at station 5 and painted arrows on the concrete at each station bordering the beach can be seen in Figure 15. Photos, such as shown in Figure 15, provide a record of the change in waterline and breaker bar throughout the tests. The waves were then turned on and usually, within 5 minutes of the start, an overhead photo of the breaking wave was taken with the view camera. The angle between the breaking wave and the reference rope was later measured from the photo to determine the breaking angle of the wave (see Fig. 16). Note that this procedure assumes the alongshore direction remained constant throughout the test. In actuality, however, the alongshore contours are changing, as evidenced in Figure 15.

After a run-time of 30 minutes, wave data were collected for 2 minutes. A sample strip-chart record is shown in Figure 17. The wave height was determined from this record. For a given length of wave record, a horizontal line was drawn along what appeared to be the average wave-crest elevation. A horizontal line was also drawn for the wave troughs. The distance between the two lines was measured to determine the average wave height, $\overline{H}$. This procedure assumes that a nearly uniform distribution of wave heights is produced by the monochromatic wave generators.

Figure 15. Example of overhead photo.

Figure 16. Example of photo of breaking wave.

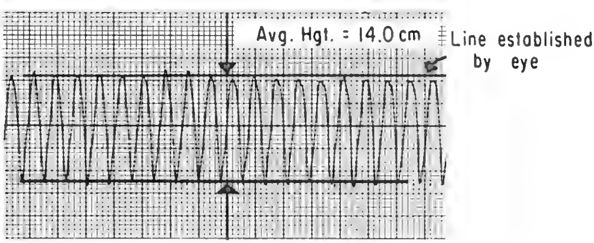

Figure 17. Example of strip-chart wave record.

Immediately after the wave data were collected, dye was injected into the surf zone, as discussed in Section III, and the leading edge of the dye was timed over a distance of approximately 4 meters (see Table 2) to determine the longshore current velocity. Also recorded were the station at which the dye left the downdrift edge of the beach and the station at which the waves were breaking. Therefore, the determination of whether the dye moved offshore, along the breaker line, or onshore could be made. Most of the dye injections traveled along the breaker line.

During the hourly cycle, sand was continually picked up from the trap area and weighed when a bin was full. A complete record of the amount of sand moved in a given time period existed only at the end of the day after the waves had been stopped and all the remaining sand had been picked up and weighed. Therefore, the longshore transport rate can be given for a daily cycle or a test cycle only.

2. Daily Cycle.

At the start of every test day (see Fig. 14), the water temperature was recorded, the water level was corrected to 0.710 meter, the wave gages were calibrated, and a check of all equipment was made. The hourly cycles were then started. Four hourly cycles were usually completed each day.

Shortly before the waves were turned off at the end of the day, photos of the surf zone were taken from the side (see Fig. 18 for examples). After the waves were stopped, all the sand in the sand trap, on the downdrift concrete apron, and in the downdrift deposition area was moved to the weighing station and weighed. The day's longshore transport movement was then determined after the final weighing. This quantity, divided by the total number of run-hours, provided the immersed weight longshore transport rate for the day.

3. Test Cycle.

At the beginning of each test, new test values for the wave period, T, the generator angle, α_g, and the generator eccentricity, Ecc, were selected and set (Fig. 14). Ecc is half the distance the generator bulkhead moves. The combination of period and eccentricity produced a predicted wave height, using the calibration curve of the generators (see Fig. 2 in Fairchild, 1970). This guided the selection of T and Ecc but was not used for wave height determination.

The beach was regraded to the shore-normal profile (see Fig. 6) before each new test. This included raking the beach to remove all traces of ripples from the prior test. The basin was usually flooded to cover the entire beach and left over a weekend to allow the new beach to stabilize before the new test cycle began.

After the test was completed, the basin was drained in 10-centimeter increments, producing depth contours of 0, 10, 20, 30, 40, 50, and 60 centimeters. An overhead photo of the waterline was taken at each increment. An example series is shown in Figure 19. Surveys of the beach were then taken, using a standard level and rod, along ranges 1.5, 2, 3, 4, 5, 6, 7, and 7.6 meters. The elevation on each range was read at all major breaks in slope.

Figure 18. Example of surf zone photos.

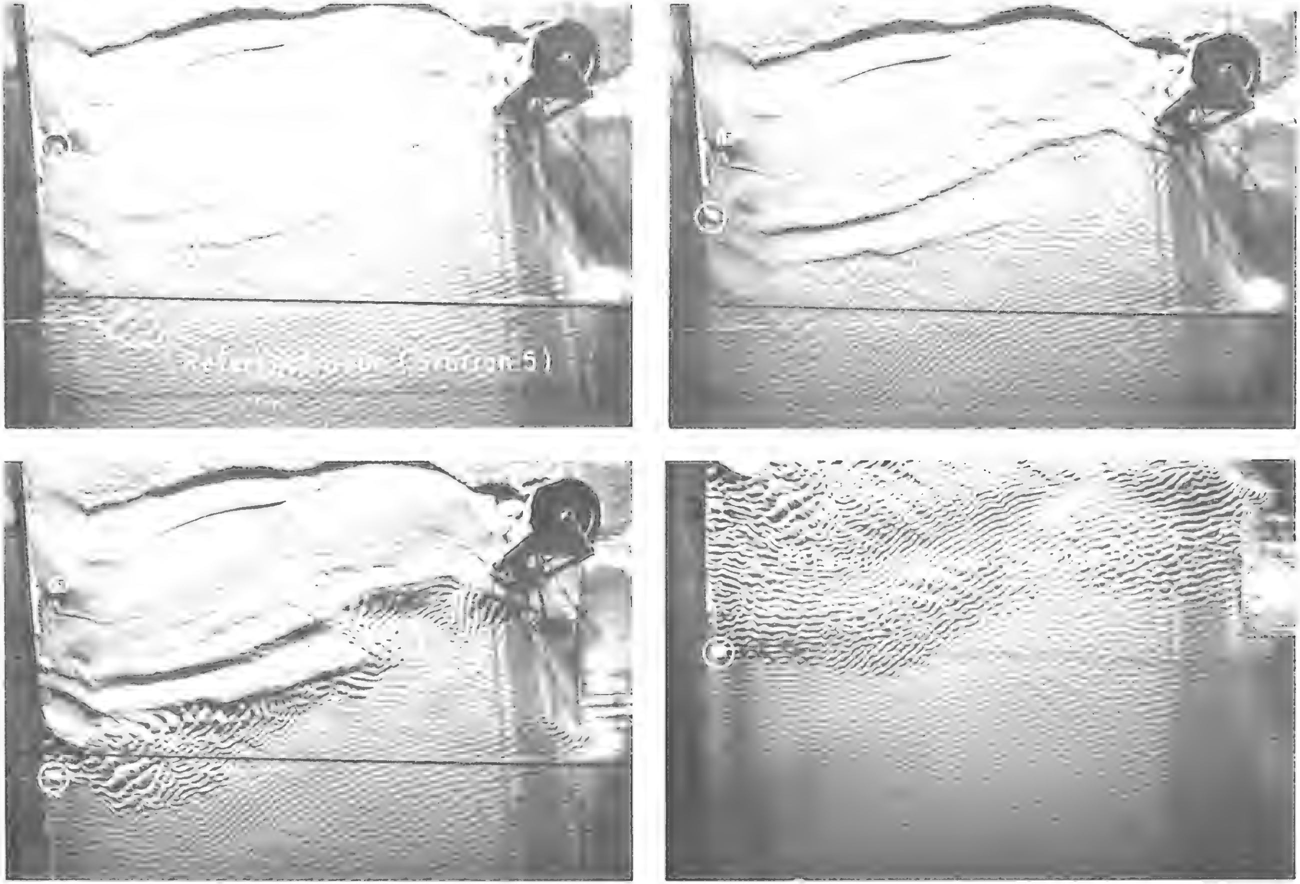

Figure 19. Example series of drainage photos.

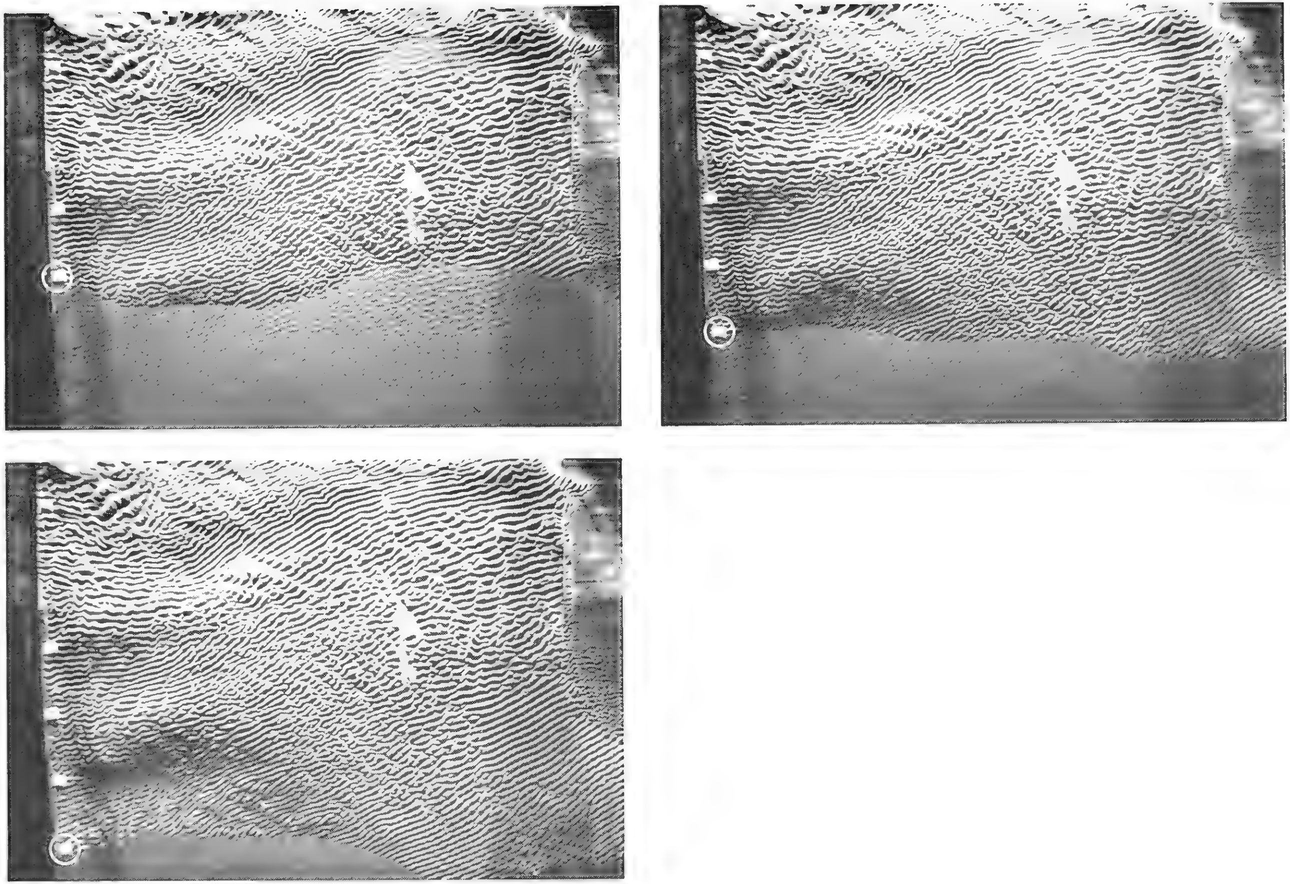

Figure 19. Example series of drainage photos.--Continued

Finally, photos of the beach were taken at close range to document important bed forms, such as ripples and bars (Fig. 20).

Figure 20. Example of bed-form photo.

4. Range of Variables.

Table 3 gives the test variables for all 15 tests. Note that the 0.710-meter water depth and the sand were the same for all tests. The wave heights listed are the average of all the hourly measurements of gages 1 and 2 for each test.

Table 3. Test cycle variables and data.

Test No.	Total run-time (hr)	Period (s)	Generator angle (degrees)	Water temperature (°C.)	Wave height (cm)	Breaker angle (degrees)	Longshore current (cm/s)	$I_\ell \cdot 10^4$ (N/s)
1	25	2.35	10	22.8	8.2	8	--[1]	6,117
2	50	2.35	10	22.8	8.0	7	--	6,890
3	24	1.50	10	20.7	12.8	7	--	8,396
4	24	1.90	10	15.9	11.5	7	--	6,188
5	24	3.00	10	12.6	7.2	3	3	7,544
6	24	2.35	20	12.3	7.7	9	17	9,966
7	24	1.90	20	11.7	10.2	11	30	7,281
8	24	1.90	20	13.8	10.0	11	20	3,446
9	24	1.50	20	14.7	10.3	15	27	5,227
10	24	1.90	20	18.8	16.5	15	29	10,605
11	24	2.35	00	20.7	7.4	-5	0	892
12	24	2.35	30	23.1	8.1	20	28	16,328
13	24	3.00	30	23.2	6.9	15	7	11,941
14	24	3.00	30	19.4	15.6	30	23	32,938
15	24	1.90	30	16.1	15.1	19	40	25,502

[1]Not available.

V. DATA

The data collected during the experiments are provided in Appendixes A to D. Appendix A contains the hourly and daily data for each test. Appendix B lists the beach survey data, which are plotted in Appendix C, taken after each test. Appendix D provides 35-millimeter photos of the beach taken during a test with the waves stopped.

1. Hourly and Daily Data in Appendix A.

Table 4 is an example of how the daily and hourly data are tabulated in Appendix A. Column 1 lists the run-time over which the data were collected. Run-time is defined as the cumulative time of wave operation from the beginning of the test. A run-time of 05 10 means that up to that point, waves had been run at the beach for a cumulative total of 5 hours and 10 minutes. This would be the case even if the first wave had been run 2 days before.

Column 2 lists the length of time (in minutes) waves were stopped to take overhead photos of the beach. The letters CFD or TC indicate that the testing was completed for the day or the test was completed. Between any two entries in column 2, the waves were run continuously. For example, from the beginning of the test at run-time 00 00 to run-time 01 00 (see Table 4), the waves were continuously run. At that point the waves were stopped for 5 minutes to take overhead photos of the beach. The waves were then restarted and run continuously until run-time 02 00.

Columns 3 and 4 list the water temperature and the water depth, respectively. These measurements were taken in the morning before the testing started and in the afternoon after the testing stopped.

Column 5 lists the immersed weight of sand moved during testing from the previous entry in the column. A value is always listed with a CFD or TC entry since it was only at the end of the day that the balance of sand not weighed during the time the waves were running could be picked up and weighed. In Table 4, the value of 4,227 immersed pounds of sand is the quantity of sand transported from run-hour 04 00 to 08 00. This column is not a cumulative listing of sand transported.

Columns 6, 7, 8, and 9 list the wave heights measured by gages 1, 2, 3, and 4A or 4B, respectively. Section III discusses the locations of these gages, which are shown in Figure 7. Column 10 lists the breaker angles measured from the Polaroid 4- by 5-inch photos of the breaking waves (see Fig. 16). Column 11 lists the longshore current velocity measured by dye injections, as discussed in Section III. Column 12 lists the breaker type, using the following code: sg, surging; p, plunging; c, collapsing; and sp, spilling. A double entry indicates both types of breakers were evident with the first type predominant.

2. Summary Data Table.

For a comparison of test conditions, Table 3 provides the average values of water temperature, wave height, wave breaker angle, longshore current velocity, and average longshore transport rate in immersed pounds per second for each test. Also included are the wave period and generator angle.

Table 4. Example of hourly and daily data tables in Appendix A.

TEST 13

PERIOD 3.00 SECONDS GENERATOR ANGLE 30 DEGREES

RUN TIME HR MN	MINUTES STOPPED	WATER TEMP CELSIUS	WATER DEPTH CM	IMMERSED WEIGHT LBS	WAVE HEIGHT CM GAGE 1	GAGE 2	GAGE 3	GAGE 4A74B	BREAKER ANGLE DEGREES	LONGSHORE CURRENT CM/S	BREAKER TYPE
0 0		22.7	71.0								
0 4									15		
0 30					6.6	7.6	7.1	7.1		6	SG
1 0	5										
1 4									15		
1 30					6.7	8.0	7.3	6.4		8	SG
2 0	10										
2 3									18		
2 43					6.1	7.6	7.0	9.1		8	SG
3 0	5										
3 3									16		
3 30					6.2	7.8	6.7	9.0		8	SG
4 0	CFD	23.1	70.8	4239							
4 0		22.9	71.0								
4 5									19		
4 30					7.2	7.0	5.9	11.9		8	SG
5 0	10										
5 5									19		
5 30					6.7	6.8	6.1	11.6		7	SG
6 0	10										
6 5									12		
6 32					6.8	6.9	6.0	11.9		8	SG
7 0	10										
7 4									13		
7 30					7.1	6.8	6.4	11.1		9	SG
8 0	CFD	23.1	71.0	4227							
8 0		23.6	71.0								
8 3									15		
8 30					6.3	7.3	7.0	11.7		9	SG
9 0	15										
9 2									15		
9 30					6.2	7.0	7.0	12.2		8	SG
10 0	CFD	23.8	70.9	1861							
10 0		23.7	71.0								
10 2									20		
10 30					6.6	6.6	6.2	10.6		6	SG
11 0	10										
11 2									14		
11 30					7.2	6.5	6.8	9.9		9	SG
12 0	10										
12 5									16		
12 30					7.1	6.4	6.9	9.4		10	SG
13 0	10										
13 4									16		
13 30					7.0	6.6	6.0	9.1		8	SG
14 0	CFD	23.5	71.0	3566							
14 0		23.5	71.0								
14 4									18		
14 30					7.1	6.8	6.5	9.2		9	SG
15 0	10										
15 3									16		
15 30					6.8	6.8	6.4	9.6		7	SG
16 0	10										
16 2									15		
16 30					6.5	6.7	5.8	8.6		7	SG
17 0	10										
17 6									12		
17 30					6.2	6.7	6.8	10.9		7	SG
18 0	CFD	22.9	71.0	3633							
18 0		22.8	71.0								
18 5									16		
18 30					6.8	7.0	6.1	6.4		5	SG
19 0	20										
19 5									18		
19 30					6.5	7.1	6.2	6.5		5	SG
20 0	60										
20 5									14		
20 30					5.9	7.8	7.3	7.5		8	SG
21 0	10										
21 5									12		
21 30					5.8	8.2	7.2	8.0		4	SG
22 0	CFD	23.1	71.0	3789							
22 0			71.0								
22 5									13		
22 30					5.7	7.6	6.5	6.8		5	SG
23 0	5										
23 3									11		
23 30					6.2	7.9	7.7	7.3		8	SG
23 55									11		
24 0	TC	23.1	71.0	1880							

[1]CFD = testing completed for day; TC = testing completed.

3. Survey Data.

After each test, the SPTB was drained and the beach was surveyed. The distance and elevation pairs are listed in Appendix B and plotted in Appendix C. The elevation datum is the stillwater level (SWL), which corresponded to a 0.710-meter water depth.

4. Overhead Photos.

Every hour during testing, the waves were stopped to take an overhead 35-millimeter photo of the beach (see Fig. 15). The photos show the waterline, the longshore bar, and the swash zone. They are useful for a qualitative description of how the beach responded to the waves. Appendix D contains a series of photos for run-times 01 00, 08 00, 16 00, and 24 00.

VI. DATA ANALYSIS

This section includes the data analysis to determine the relations between I_ℓ and S_{xy} and I_ℓ and $P_{\ell b}$. The empirical coefficients found from these relations are then, in turn, related to the surf similarity parameter, ξ, which is adapted to the data collected. Also included is an explanation of the calculations of S_{xy}, $P_{\ell b}$, ξ, and I_ℓ, along with plots of the various relationships. The wave height used in the calculations is that measured at the toe of the beach (average of gages 1 and 2 wave heights). The breaker wave height, which would have been a better value, was not used for the following reasons. The wave height at the toe of the beach was measured for all 15 tests; the breaker height was not. Also, only one gage was used to measure breaker height, while two were used at the beach toe. The significant difference in height between waves measured at the two beach toe gages (see App. A) indicates that some wave height variability existed along the wave crest. Therefore, the average of the measurements at the two beach toe gages is probably a more reliable estimate of the entire wave passing the toe than the one gage measurement at the breaker is of the entire breaker wave. A comparison of the data in this report with past studies is shown in a Q versus $P_{\ell b}$ graph.

1. Calculation of S_{xy}.

Equation (7)

$$S_{xy} = \left(\frac{\rho g \overline{H}^2}{8} C_g \cos\alpha \right) \frac{\sin\alpha}{C}$$

was used to calculate S_{xy}. Rearranging the equation,

$$S_{xy} = \frac{\rho g}{16} \overline{H}^2 n \sin 2\alpha \qquad (21)$$

where n is the ratio C_g/C and a function of the water depth and wave period or length. S_{xy} was calculated at the toe of the beach by using the average of the wave heights measured at that location (see Fig. 7), and by using the generator angle for α. This was calculated for each set of wave data. Thus, for the standard 24-hour test, 24 values of S_{xy} were calculated (see App. E). The average of S_{xy} for each test is listed in Table 5.

Table 5. Test cycle calculations.

Test	Total run time (hr)	S_{xy} (N/m)	$P_{\ell b}$ (J/m/s)	I_ℓ (N/s)	K_s (m/s)	K_p	ξ
1	25	1.179	2.201	0.6116	0.5190	0.2779	0.6604
2	30	1.137	2.043	0.6889	0.6058	0.3373	0.6686
3	24	2.280	3.232	0.8396	0.3682	0.2598	0.3374
4	24	2.158	3.615	0.6188	0.2868	0.1712	0.4508
5	24	0.987	0.789	0.7544	0.7640	0.9557	0.8997
6	24	1.977	2.144	0.9966	0.5042	0.4648	0.6815
7	24	3.161	4.158	0.7281	0.2303	0.1751	0.4787
8	24	3.018	3.918	0.3446	0.1142	0.0880	0.4835
9	24	2.808	4.286	0.5227	0.1862	0.1220	0.3761
10	24	8.250	14.761	1.0605	0.1285	0.0718	0.3764
12	24	2.942	4.839	1.6328	0.5550	0.3374	0.6644
13	24	2.241	2.948	1.1941	0.5328	0.4051	0.9190
14	24	11.578	28.802	3.2938	0.2845	0.1144	0.6112
15	24	9.253	13.536	2.5502	0.2756	0.1884	0.3934

2. Calculation of $P_{\ell b}$.

Equation (10)

$$P_{\ell b} = \left(\frac{\rho g \overline{H}^2}{8} C_g \cos\alpha\right)_i \sin\alpha_b$$

was used to calculate $P_{\ell b}$. The term in the parentheses, like S_{xy}, was calculated at the toe of the beach. However, the sine term used the breaker angle as measured from the photos of the breaking waves. The breaker angle used in the calculation was the average of the breaker angles collected 30 minutes before and after the wave data were collected (see Fig. 14). $P_{\ell b}$ was calculated for each set of wave data, 24 values of $P_{\ell b}$ were calculated for the standard 24-hour test (see App. E). The average of $P_{\ell b}$ for each test is listed in Table 5.

3. Calculation of ξ.

The surf similarity parameter of Kamphuis and Readshaw (1978) was presented in equation (17) as

$$\xi_b = \frac{\tan\beta}{\left(H_b/L_o\right)^{1/2}}$$

For the data in this report, a different surf similarity parameter is needed since $\overline{H}$ will be substituted for H_b, as discussed at the beginning of this section. Therefore, the surf similarity parameter in the following analysis is

$$\xi = \frac{\tan\beta}{\left(\overline{H}/L_o\right)^{1/2}} \qquad (22)$$

The same beach slope was used for all 15 tests and was determined as shown in Figure 21. A value of ξ was calculated for each test using the average $\overline{H}$ for the entire test. These values are listed in Table 5.

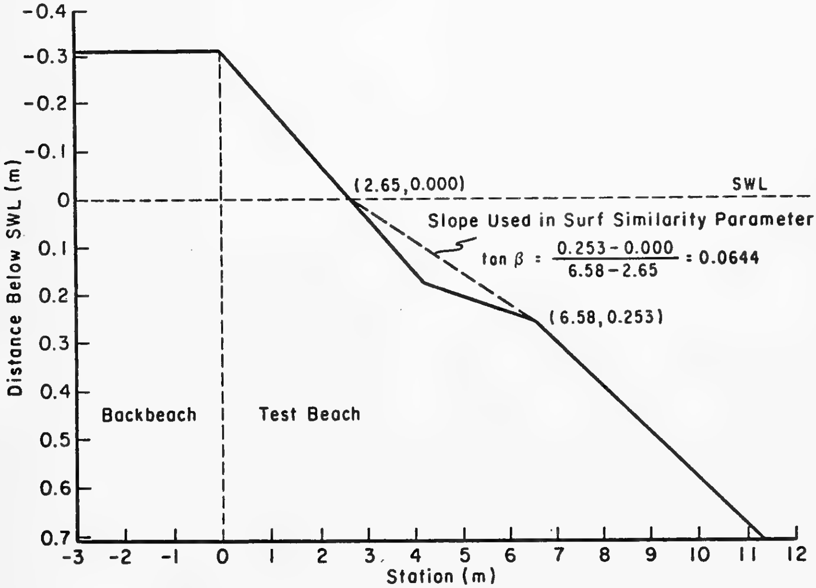

Figure 21. Determination of beach slope used to calculate the surf similarity parameter.

4. Special Tests.

Three tests were performed under special circumstances. Test 2 was a repeat of test 1; test 8 was a repeat of test 7, except the sand feeder was moved shoreward; and test 11 was done with a generator angle of zero.

Tests 1 and 2 were both run with a period of 2.35 seconds, a generator angle of 10°, and a generator eccentricity of 5.97 centimeters. Test 1 ran for 25 hours, test 2 for 50 hours. A twofold comparison of the two tests was originally planned. The first 25 hours of test 2 data was to be compared to the test 1 data, and then, both sets of data were to be compared to the last 25 hours of test 2. Unfortunately, due to an experimental error, only the first 30 hours of the test 2 longshore transport data was collected accurately. Therefore, the only comparison made was test 1 to the first 30 hours of test 2. Reference to test 2 in the remainder of the report refers to the first 30 hours only. Appendix A contains all 50 hours of test 2 data.

Table 6 compares the results of the two tests. The differences listed give an indication of the repeatability of the data collection. The longshore transport rate changed by 12.6 percent, which is a significant variation. This is an inherent problem of longshore transport tests, indicating that some important unknown factors are at work.

Table 6. Comparison of tests 1 and 2.

Test	Total run-time (hr)	Avg $\bar{H}$ (cm)	Avg α_b (degrees)	I_ℓ (N/s)	S_{xy} (N/m)	$P_{\ell b}$ (J/m/s)
1	25	8.17	8	0.612	1.18	2.20
2	30	8.03	7	0.689	1.14	2.04
Pct difference[1]		-1.7	-12.5	+12.6	-3.4	-7.3

[1]Pct difference = $\frac{(\text{Test 1} - \text{Test 2})\ 100}{\text{Test 1}}$.

Tests 7 and 8 were both run with a period of 1.90 seconds, a generator angle of 20°, and a generator eccentricity of 5.97 centimeters. The only difference was that the sand feeder, which was located at the SWL for all other tests, was moved shoreward 1.4 meters for test 8. The feeder was moved because the shoreline at the end of test 7 significantly angled shoreward toward the downdrift side of the beach. This can be seen in the test 7 photos in Appendix D. The feeder was moved shoreward to see if a straight shoreline resulted. It did, as the photos in Appendix D for test 8 show. Another major effect was the change in I_ℓ from 0.728 newton per second for test 7 to 0.345 newton per second for test 8, a decrease of 53 percent. Test 8 is excluded from the remaining data analyses.

Test 11 was run with a period of 2.35 seconds, a generator angle of 0°, and a generator eccentricity of 5.97 centimeters. The test was meant as a control to determine the amount of sand moved by the diffusion caused by breaking waves. This value of I_ℓ for test 11 was 0.089 newton per second. A comparable quantity of sand, 0.059 newton per second, also moved updrift. Test 11 is also excluded from the remaining data analyses.

5. Daily Cycle Graphs.

As discussed previously, longshore transport could be measured only on a daily cycle or test cycle basis. For the typical 24-hour test, six values of longshore transport rate were calculated. Each rate covered a period of 4 run-hours. During this time period, four values of S_{xy} and $P_{\ell b}$ were calculated, averaged, and related to the corresponding value of I_ℓ. These values are listed in Appendix F and plotted in Figures 22 and 23. Table 7 lists the important statistical parameters.

Table 7. Daily cycle statistics.

Relation	Figure No.	r^2	Least squares lines		
			Standard slope	Y-intercept	Through origin slope
I_ℓ versus S_{xy}	22	0.74	0.21	0.38	0.28
I_ℓ versus $P_{\ell b}$	23	0.73	0.09	0.58	0.13

The square of the correlation coefficients, r^2, represents the fraction of the variation of I_ℓ about its mean which is explained by the abscissa term. r^2 for S_{xy} and $P_{\ell b}$ are 0.74 and 0.73, respectively. These numbers show that I_ℓ correlates well with both terms to approximately equal degrees. The least squares lines listed in Table 7 are in Figures 22 and 23, which also include the least squares lines calculated with the limitation that the lines pass through the origin. The slopes of these lines are 0.28 for the I_ℓ versus S_{xy} graph and 0.13 for the I_ℓ versus $P_{\ell b}$ graph.

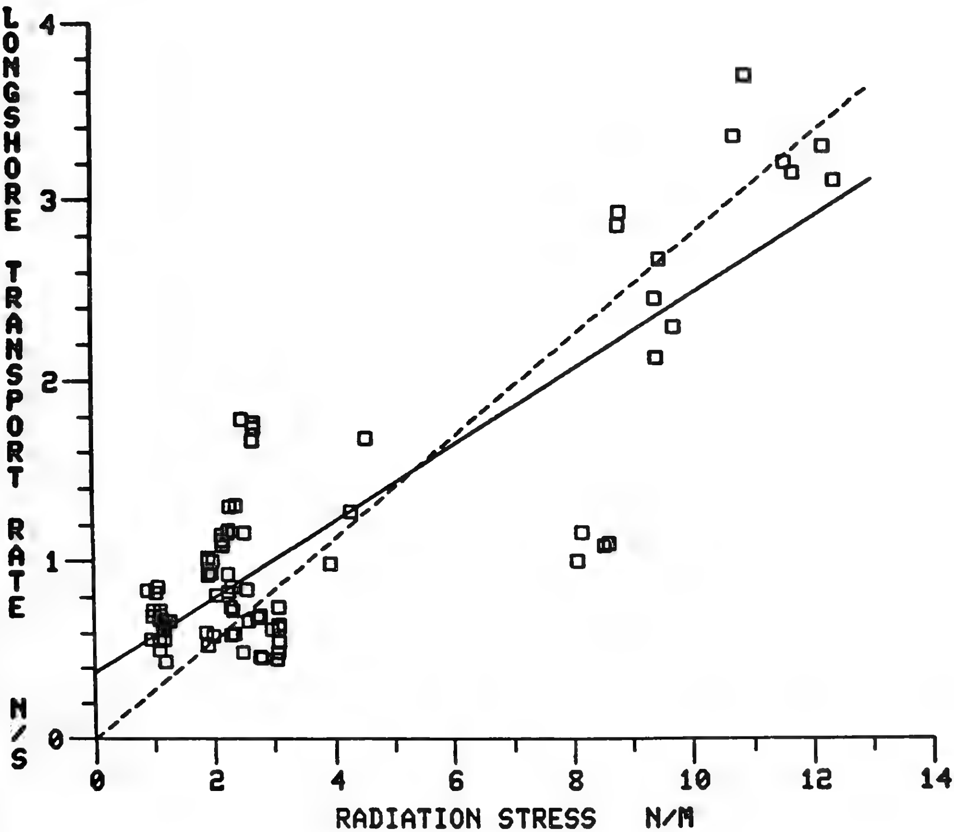

Figure 22. Relation between longshore transport rate, I_ℓ, and radiation stress, S_{xy}, using daily cycle data (tests 8 and 11 excluded).

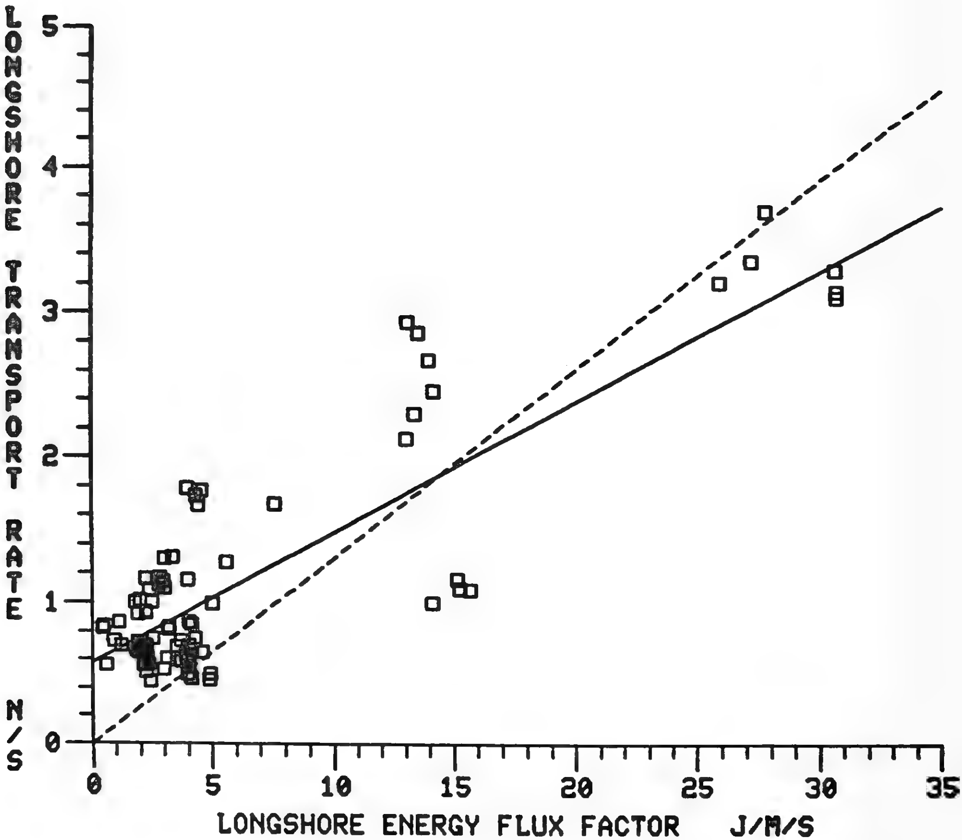

Figure 23. Relation between longshore transport rate, I_ℓ, and longshore energy flux factor, $P_{\ell b}$, using daily cycle data (tests 8 and 11 excluded).

6. Test Cycle Graphs.

The average longshore transport rate for each test was calculated and compared with the test average of S_{xy} and $P_{\ell b}$. These values are listed in Table 5 and plotted in Figures 24 and 25. Statistical values are in Table 8. r^2 for I_ℓ versus S_{xy} and I_ℓ versus $P_{\ell b}$ are 0.72 and 0.74, respectively. As with the daily cycle calculations, I_ℓ is shown to correlate well with both terms to approximately equal degrees. Figures 24 and 25 include both the standard least squares line and the least squares line forced through the origin. The slopes of the latter lines are 0.26 for the I_ℓ versus S_{xy} graph and 0.13 for the I_ℓ versus $P_{\ell b}$ graph.

Table 8. Text cycle statistics.

Relation	Figure No.	r^2	Least squares lines		
			Standard slope	Y-intercept	Through origin slope
I_ℓ versus S_{xy}	24	0.72	0.21	0.40	0.26
I_ℓ versus $P_{\ell b}$	25	0.74	0.09	0.58	0.13
K_s versus ξ	26	0.70	0.82	-0.07	
K_p versus ξ	27	0.56	0.89	-0.22	

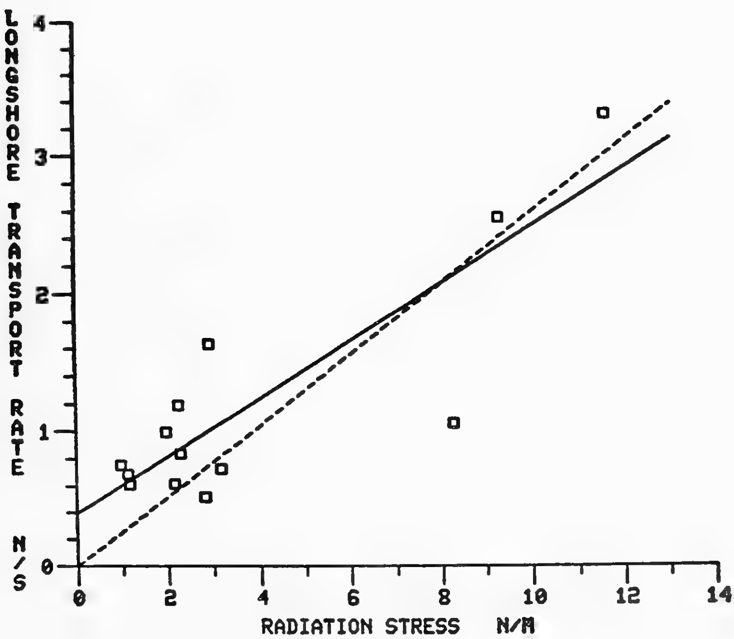

Figure 24. Relation between longshore transport rate, I_ℓ, and radiation stress, S_{xy}, using test cycle data (tests 8 and 11 excluded).

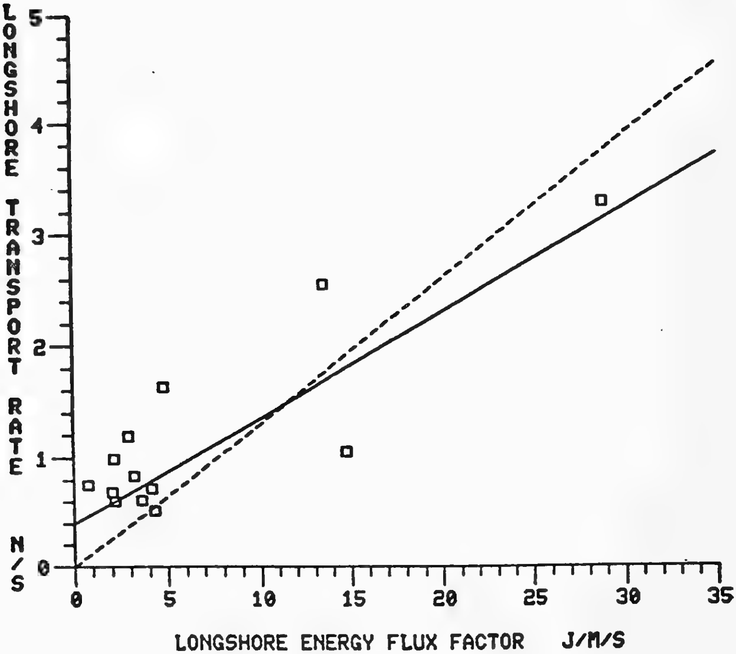

Figure 25. Relation between longshore transport rate, I_ℓ, and longshore energy flux factor, $P_{\ell b}$, using test cycle data (tests 8 and 11 excluded).

7. Surf Similarity Relation.

Figures 26 and 27 were drawn to test the dependence of K_s and K_p on ξ. Test numbers are indicated in the figures. Table 8 lists the statistics. The K terms were calculated using equations (15) and (16). These graphs show that K is far from being constant, as is commonly assumed, and that it is strongly related to ξ.

8. Comparison to Past Data.

The units of I_ℓ and $P_{\ell b}$ were converted to those used in the SPM and plotted in Figure 28, which is taken from Figure 4-36 of the SPM. The SPM figure was modified by shifting the x-axis to convert from $P_{\ell s}$ to $P_{\ell b}$. Equation (13) shows the relation between $P_{\ell b}$ and $P_{\ell s}$. Test numbers for the data points of this report are noted in Figure 28.

Two major observations are immediately apparent. The first is that the laboratory data in this report, as in laboratory data from past reports, have considerable scatter. Since the surf similarity parameter, ξ, in this report varies by a significant amount for the different tests, as shown in Figures 26 and 27, some scatter is expected. The surf similarity parameter, of course, does not explain all of the scatter in the laboratory data. There are still some laboratory and scale effects which are not yet understood.

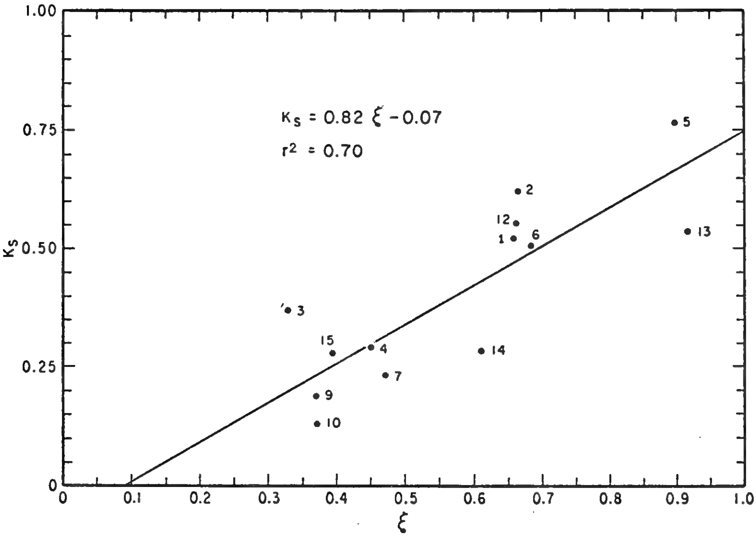

Figure 26. Relation between K_s and the surf similarity parameter, ξ, using test cycle data (tests 8 and 11 excluded).

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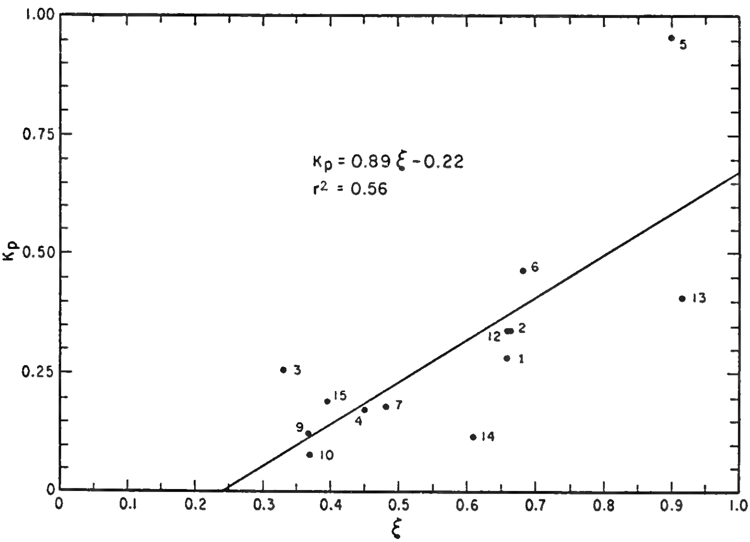

Figure 27. Relation between K_p and the surf similarity parameter, ξ, using test cycle data (tests 8 and 11 excluded).

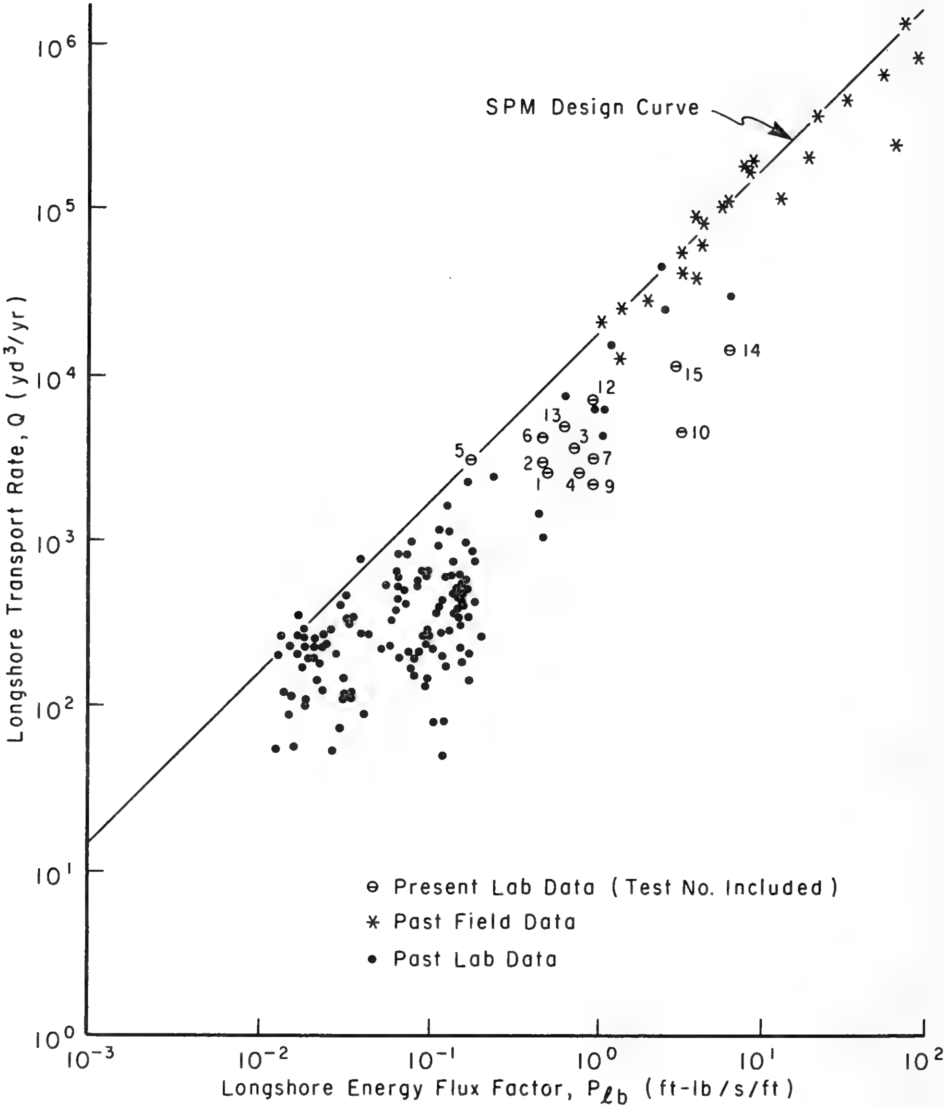

Figure 28. Comparison of data in this report to past reports, using SPM Figure 4-36 (tests 8 and 11 excluded).

The second observation is that most of the data fall beneath the SPM curve connoting low values of K_p. Since the SPM curve is based on field data, mostly from Komar and Inman (1970), a possible explanation is that the field data were collected under conditions of higher values of ξ than those for the laboratory data. Kamphuis and Readshaw (1978) suggest that Komar and Inman's data were indeed collected under conditions of high ξ_b. It seems reasonable to assume that the ξ values were also high.

VII. SUMMARY AND CONCLUSIONS

An analysis of the radiation stress, S_{xy}, and the energy flux factor, $P_{\ell b}$, shows that both predict longshore transport rate, I_ℓ, to comparable degrees. Approximately 70 percent of the variance of I_ℓ about its mean is explained by each term. There appears to be no major advantage in choosing one over the other to predict the longshore transport rate. However, S_{xy} has the advantage of being constant seaward of the breaker zone while $P_{\ell b}$ is not. This makes the calculation of S_{xy} more convenient than $P_{\ell b}$, which must be determined at the breaker line. On the other hand, $P_{\ell b}$ has the advantage of having the same units as I_ℓ, which means that K_p is dimensionless.

The empirical coefficients, K_s and K_p, are far from constant although K_p is commonly assumed to be so in practice. Part of the variation of the coefficients can be related to the variation of the surf similarity parameter, ξ, as shown in Figures 26 and 27. These figures show that K_s and K_p will increase with ξ. The considerable scatter evident in Figure 28 can be partly explained by the relation between the empirical coefficients and ξ. The data in this report and past laboratory and field data are compared in Figure 28. The laboratory data generally predict lower values of I_ℓ for a given $P_{\ell b}$ compared to the field data. Part of this trend can be explained by the differences in the surf similarity parameters, assuming the field data were collected under conditions of high ξ. Also, laboratory and scale effects probably contribute to the lower laboratory transport rates. The relative importance of these factors is suggested as a subject of future research.

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APPENDIX A

HOURLY AND DAILY DATA

The data in this appendix are available on computer cards from CEIAC.

TEST 01

PERIOD 2.35 SECONDS GENERATOR ANGLE 10 DEGREES

RUN TIME HR MN	MINUTES STOPPED[1]	WATER TEMP CELSIUS	WATER DEPTH CM	IMMERSED WEIGHT LBS	WAVE HEIGHT CM GAGE 1	GAGE 2	GAGE 3	GAGE 4A/4B	BREAKER ANGLE DEGREES	LONGSHORE CURRENT CM/S	BREAKER TYPE
0 0			71.0								
0 30									8		
0 40					10.0	6.4					
1 0	CFD			360							
1 0		23.5	71.0								
1 10									[illegible]		
1 32					9.0	6.8					
2 0	CFD			412							
2 0			71.0								
2 8									[illegible]		
2 32					10.0	6.2					
3 0	43										
3 10											
3 30					10.2	6.6					
4 0											
4 10									8		
4 30					9.0	7.0					
5 0	CFD			1376							
5 0									10		
5 40					8.4	6.4					
6 0											
6 35									8		
6 40					9.2	6.8					
7 0	40										
7 0											
7 3									8		
7 30					10.2	6.4					
8 0											
8 7									7		
8 30					9.8	6.0					
9 0	CFD			1810							
9 0		22.5	71.0								
9 5									9		
9 30					9.0	7.2					
10 5									[illegible]		
10 30					9.4	7.2					
11 5									9		
11 30					10.2	5.6					
12 0	40										
12 5									[illegible]		
12 30					10.0	6.2					
13 0											
13 7									- 7		
13 30					10.6	6.2					
14 0	CFD			2508							
14 0		22.5	71.0						[illegible]		
14 30					9.2	8.0					
15 0									6		
15 30					9.6	7.4					
16 0									8		
16 30					9.6	7.4					
17 0									8		
17 10					11.0	6.2					
18 0	60								[illegible]		
18 30					10.0	6.8					
19 5									[illegible]		
19 30					10.6	6.0					
20 0	CFD			3266							
20 0		22.8	71.0								
20 5									[illegible]		
20 30					10.0	5.6					
21 0											
21 5									7		
21 30					9.0	7.0					
22 0											
22 5									7		
22 30					10.2	6.6					
23 0	60										
23 5									7		
23 30					10.0	5.8					
24 0									8		
24 30					10.6	6.0					
24 55									6		
25 0	TC			2644							

TEST [illegible]

PERIOD 2.35 SECONDS GENERATOR ANGLE 10 DEGREES

RUN TIME HR MN	MINUTES STOPPED	WATER TEMP CELSIUS	WATER DEPTH CM	IMMERSED WEIGHT LBS	GAGE 1	GAGE 2	GAGE 3	GAGE 4A/4B	BREAKER ANGLE DEGREES	LONGSHORE CURRENT CM/S	BREAKER TYPE
0 0		22.5	71.0								
0 10									7		
0 30					10.4	5.8					
1 0											
1 22									7		
1 30					10.4	5.8					
2 0											
2 5									7		
2 30					10.4	6.4					
3 3									8		
3 30					10.0	6.4					
4 0											
4 5									8		
4 30					10.4	6.8					

[1] CFD = testing completed for day; TC = testing completed.

TEST 02 CONT

RUN TIME HR	MN	MINUTES STOPPED	WATER TEMP CELSIUS	WATER DEPTH CM	IMMERSED WEIGHT LBS	WAVE HEIGHT CM GAGE 1	GAGE 2	GAGE 3	GAGE 4A/4B	BREAKER ANGLE DEGREES	LONGSHORE CURRENT CM/S	BREAKER TYPE
5	0											
5	7									6		
5	30					10.4-	6.4					
6	0	CFD			3252							
6	0			71.0						8		
6	30					9.2	5.6					
7	5									7		
7	30					10.0	5.4					
8	0											
8	5									9		
8	30					10.8	6.2					
9	0	CFD			1644							
9	0		21.5	71.0								
9	5									7		
9	30					9.2	6.2					
10	0									7		
10	30					8.4	7.8					
11	0									7		
11	30					9.6	6.6					
12	3									6		
12	30					9.6	6.4					
13	2									9		
13	30					9.4	6.6					
14	0	CFD			2944							
14	0		21.5	71.0								
14	2									6		
14	30					9.5	6.4					
15	2									6		
15	30					10.0	6.0					
16	0									7		
16	30					9.9	6.0					
17	0											
17	2									7		
17	30					9.8	6.0					
18	0											
18	4									8		
18	30					10.0	6.0					
19	3									7		
19	30					9.5	6.4					
20	0	CFD			3290-							
20	0			71.0								
20	5									7		
20	30					9.2	6.4					
21	5									7		
21	30					9.3	6.1					
22	0											
22	15									8		
22	30					9.9	6.4					
23	0											
23	5									8		
23	30					9.8	6.3					
24	0											
24	3									10		
24	30					9.6	6.7					
25	0	CFD			2844							
25	0		22.0	71.0								
25	5									9		
25	30					7.5	6.8					
26	5									9		
26	30					10.2	6.6					
27	0											
27	5									9		
27	30					9.8.	6.1					
28	0											
28	5									9		
28	30	60				10.1	6.2					
28	35									6		
29	0					9.7	6.8					
29	35									2		
30	0					9.7	6.4					
30	0	CFD			2754							
30	0		23.0	71.0								
30	5									7		
30	30					9.7	6.1					
31	0											
31	10									5		
31	30					9.0	7.1					
32	0											
32	10									6		
32	30					9.5	7.2					
33	0											
33	10									8		
33	30					9.6	6.2					
34	0	75										
34	5									6		
34	30					9.2	5.8					
35	0	CFD										
35	0		23.7	71.0								
35	10									6		
35	30					8.7	7.3					
36	0											
36	5									5		
36	30					9.3	6.5					
37	0											
37	5									7		
37	30					9.4	6.6					
38	0											
38	10									4		
38	30	65								5		

TEST 02 CONT

RUN TIME HR MN	MINUTES STOPPED[1]	WATER TEMP CELSIUS	WATER DEPTH CM	IMMERSED WEIGHT LBS	WAVE HEIGHT CM GAGE 1	GAGE 2	GAGE 3	GAGE 4A/4B	BREAKER ANGLE DEGREES	LONGSHORE CURRENT CM/S	BREAKER TYPE
39 0					10.8	5.7					
39 48									6		
39 58					10.0	7.0					
40 0	CFD										
40 0		23.5	71.0								
40 15									5		
40 30					9.2	7.1					
41 0											
41 5									5		
41 30					9.1	7.3					
42 5									6		
42 30					9.3	7.0					
43 0											
43 10									7		
43 30					9.6	7.6					
44 0	60										
44 2									5		
44 30					9.9	6.6					
45 0	CFD										
45 0		24.5	71.0								
45 5									6		
45 30					9.8	5.4					
46 1									6		
46 40					9.7	6.3					
47 0											
47 8									7		
47 30					9.2	5.6					
48 0											
48 6									7		
48 30					9.1	5.9					
49 0	50										
49 5									6		
49 30					9.3	6.9					
50 0	TC										

TEST 03

PERIOD 1.50 SECONDS GENERATOR ANGLE 10 DEGREES

RUN TIME HR MN	MINUTES STOPPED	WATER TEMP CELSIUS	WATER DEPTH CM	IMMERSED WEIGHT LBS	GAGE 1	GAGE 2	GAGE 3	GAGE 4A/4B	BREAKER ANGLE DEGREES	LONGSHORE CURRENT CM/S	BREAKER TYPE
0 0		22.5	71.0								
0 17									8		
0 30					13.2	12.3					
1 0	5										
1 6									8		
1 30					13.1	11.6					
2 0	5										
2 3									8		
2 30					12.7	12.4					
3 0	80										
3 4									9		
3 30					12.4	15.1					
4 0	CFD	22.0	70.9	2792							
4 0		21.8	71.1								
4 5									9		
4 30					13.1	14.6					
5 0	5										
5 4									8		
5 30					13.2	14.7					
6 0	5										
6 5									8		
6 30					12.8	13.3					
7 0	CFD	21.8	70.7								
7 0		21.0	71.0								
7 6									7		
7 28					13.6	12.9					
8 0	CFD	21.0	71.0	2752							
8 0		21.0	71.0								
8 10									7		
8 30					11.0	13.9					
9 0	5										
9 5									2		
9 30					9.7	15.3					
10 0	110										
10 3									6		
10 30					11.8	14.4					
11 0	5										
11 5									5		
11 30					11.3	14.0					
12 0	CFD	21.0	70.9	3018							
12 0		20.5	71.0								
12 6									5		
12 30					11.3	15.0					
13 0	5										
13 5									5		
13 30					13.2	13.2					
14 0	115										
14 5									4		
14 30					11.4	10.6					
15 0	5										
15 2									5		
15 30					12.8	14.5					
16 0	CFD	20.2	70.9	2420							
16 0		19.5	71.0								
16 2									9		
16 30					12.0	12.2					
17 0	5										
17 3									7		
17 30					12.1	11.6					

TEST 03 CONT

RUN TIME HR	MN	MINUTES STOPPED	WATER TEMP CELSIUS	WATER DEPTH CM	IMMERSED WEIGHT LBS	WAVE HEIGHT CM GAGE 1	GAGE 2	GAGE 3	GAGE 4A/4B	BREAKER ANGLE DEGREES	LONGSHORE CURRENT CM/S	BREAKER TYPE
18	0	100										
18	3									7		
18	30					12.4	12.2					
19	0	5										
19	2									6		
19	30					12.8	11.8					
20	0	CFD	19.0	71.0	2626							
20	0		18.0	71.0								
20	3									10		
20	30					13.1	13.2					
21	0	5										
21	4									11		
21	30					12.1	11.3					
22	0	115										
22	8									8		
22	30					12.9	11.8					
23	0	5										
23	3									2		
23	30					13.2	13.6					
24	0	TC			2700					4		

TEST 04

PERIOD 1.90 SECONDS GENERATOR ANGLE 10 DEGREES

RUN TIME HR	MN	MINUTES STOPPED	WATER TEMP CELSIUS	WATER DEPTH CM	IMMERSED WEIGHT LBS	WAVE HEIGHT CM GAGE 1	GAGE 2	GAGE 3	GAGE 4A/4B	BREAKER ANGLE DEGREES	LONGSHORE CURRENT CM/S	BREAKER TYPE
0	0		15.0	71.0								
0	4									8		
0	30					9.6	11.5					
1	0	5										
1	5									8		
1	30					10.4	13.2					
2	0	115										
2	3									6		
2	30					11.1	13.8					
3	0	5										
3	2									6		
3	30					11.0	15.4					
4	0	CFD	15.0	71.0	2360							
4	0		16.0	71.0								
4	6									8		
4	30					11.9	16.2					
5	0	5										
5	3									6		
5	30					11.0	14.2					
6	0	115										
6	4									8		
6	30					10.8	13.8					
7	0	5										
7	2									7		
7	30					10.2	12.8					
8	0	CFD	15.8	70.9	2164							
8	0		14.9	71.0								
8	11									6		
8	30					11.8	12.5					
9	0	5										
9	7									9		
9	30					11.2	13.2					
10	0	115										
10	5									7		
10	30					10.0	12.7					
11	0	5										
11	7									8		
11	30					10.0	13.7					
12	0	CFD	15.2	71.0	1912							
12	0		16.2	71.0								
12	8									7		
12	30					10.3	12.3					
13	0	5										
13	5									9		
13	30					10.1	12.5					
14	0	115										
14	5									8		
14	30					9.4	12.0					
15	0	5										
15	5									8		
15	30					9.5	12.8					
16	0	CFD	15.8	71.0	1896							
16	0		17.0	71.0								
16	4									8		
16	30					9.9	13.3					
17	0	5										
17	3									8		
17	30					9.4	11.8					
18	0	110										
18	3									7		
18	30					8.8	11.8					
19	0	5										
19	5									7		
19	30					8.8	12.4					
20	0	CFD	16.5	71.0	1968							
20	0		16.5	71.0								
20	3									6		
20	30					10.4	13.7					
21	0	5										
21	3									6		
21	30					10.4	12.4					
22	0	115										
22	4									8		
22	30					8.5	11.3					
23	0	5										

TEST 04 CONT

RUN TIME HR MN	MINUTES STOPPED	WATER TEMP CELSIUS	WATER DEPTH CM	IMMERSED WEIGHT LBS	WAVE HEIGHT CM GAGE 1	GAGE 2	GAGE 3	GAGE 4A/4B	BREAKER ANGLE DEGREES	LONGSHORE CURRENT CM/S	BREAKER TYPE
23 3									8		
23 30					8.1	11.6					
23 56									6		
24 0	TC	16.5	71.0	1720							

TEST 05

PERIOD 3.00 SECONDS GENERATOR ANGLE 10 DEGREES

RUN TIME HR MN	MINUTES STOPPED	WATER TEMP CELSIUS	WATER DEPTH CM	IMMERSED WEIGHT LBS	GAGE 1	GAGE 2	GAGE 3	GAGE 4A/4B	BREAKER ANGLE DEGREES	LONGSHORE CURRENT CM/S	BREAKER TYPE
0 0		12.0	71.0								
0 5									4		
0 30					6.0	6.9	8.2	11.8			
1 0	5										
1 2									2		
1 30					7.0	8.1	7.9	10.0			
2 0	90										
2 2									2		
2 30					6.8	7.6	7.9	9.8			
3 0	5										
3 2									2		
3 30					6.8	7.6	8.2	11.4			
4 0	CFD	11.5	70.9	1832							
4 0		11.5	71.0								
4 3									4		
4 30					5.9	7.4	7.6	10.4			
5 0	5										
5 2									1		
5 30					6.0	6.8	6.9	9.8			
6 0	115										
6 3									2		
6 30					6.7	7.8	8.1	11.0			
7 0	5										
7 3									3		
7 30					7.0	7.4	8.6	10.0			
8 0	CFD	11.5	70.9	2724							
8 0		11.0	71.0								
8 2									1		
8 30					6.8	9.0	10.2	10.4			
9 0	5										
9 4									2		
9 30					6.4	8.0	8.6	10.2			
10 0	85										
10 4									2		
10 30					6.6	8.2	9.1	10.6			
11 0	5										
11 3									0		
11 30					6.2	8.0	8.0	10.4			
12 0	CFD			2674							
12 0		13.0	71.0								
12 3									1		
12 30					6.4	7.7	8.0	9.6			
13 0	5										
13 2									8		
13 30					6.6	8.0	8.2	9.2			
14 0	40										
14 2									5		
14 30					7.0	7.8	7.1	9.0			
15 0	5										
15 3									4		
15 30					6.2	8.2	8.3	9.7			
16 0	CFD	13.0	70.9	2370							
16 0		14.0	71.0								
16 3									2		
16 30					7.4	7.7	7.2	9.2		2	P-SG
17 0	5										
17 8									3		
17 30					7.6	7.8	8.4	9.2		3	P-SG
18 0	115										
18 3									7		
18 30					6.4	8.7	9.1	9.9		2	P-SG
19 0	5										
19 3									4		
19 30					6.5	8.5		10.0		3	
20 0	CFD	14.0	70.9	2788							
20 0		14.0	71.0								
20 10									3		
20 30					6.4	7.4	7.7	9.0		3	SG
21 0	5										
21 2									0		
21 30					7.2	6.8	7.3	8.8			SG
22 0	85										
22 2									10		
22 30					6.9	7.8	8.1	9.3		3	SG
23 0	5										
23 4									2		
23 30					6.7	8.0	7.8	9.6		3	SG
23 56									3		
24 0	TC	13.6	70.9	2266							

TEST 06

PERIOD 2.35 SECONDS GENERATOR ANGLE 20 DEGREES

RUN TIME HR MN	MINUTES STOPPED	WATER TEMP CELSIUS	WATER DEPTH CM	IMMERSED WEIGHT LBS	GAGE 1	GAGE 2	GAGE 3	GAGE 4A/4B	BREAKER ANGLE DEGREES	LONGSHORE CURRENT CM/S	BREAKER TYPE
0 0			71.0								
0 7									13		
0 30					10.1	5.7	7.9	10.0		17	P
1 0	5										
1 2									8		
1 30					9.6	5.8	7.3	8.6		15	P

TEST 06 CONT

RUN TIME HR MN	MINUTES STOPPED	WATER TEMP CELSIUS	WATER DEPTH CM	IMMERSED WEIGHT LBS	WAVE HEIGHT CM GAGE 1	GAGE 2	GAGE 3	GAGE 4A/4B	BREAKER ANGLE DEGREES	LONGSHORE CURRENT CM/S	BREAKER TYPE
2 0	115										
2 2									10		
2 30					10.2	5.5	6.4	8.2		17	SP-P
3 0	5										
3 4									11		
3 30					9.8	5.5	6.6	8.6		17	SP-P
4 0	CFD	10.5	71.0	3242							
4 0		11.5	71.0								
4 3									11		
4 30					9.6	6.6	7.8	9.6		19	P
5 0	5										
5 3									10		
5 30					9.2	6.0	7.0	8.6		17	P
6 0	115										
6 7									9		
6 30					8.5	6.8	7.1	8.4		18	P
7 0	5										
7 5									9		
7 30					8.3	6.7	8.2	9.2		15	P
8 0	CFD	11.8	70.9	3040							
8 0		12.0	71.0								
8 4									7		
8 30					9.3	6.1	6.8	9.6		16	P
9 0	5										
9 4									8		
9 30					8.8	6.0	7.0	9.0		17	P
10 0	80										
10 3									10		
10 30					8.4	6.6	7.4	9.0		15	P
11 0	5										
11 8									7		
11 30					9.4	6.1	6.5	9.9		15	P
12 0	CFD	12.0	71.0	2990							
12 0		12.0	71.0								
12 5									9		
12 30					9.1	6.1	7.0	9.1		17	P
13 0	5										
13 5									9		
13 30					8.5	6.8	7.2	9.0		17	P
14 0	100										
14 8									9		
14 30					9.1	6.0	7.2	8.8		19	P
15 0	5										
15 3									6		
15 30					8.8	6.4	6.5	8.8		18	P
16 0	CFD	12.5	70.9	3304							
16 0		14.0	71.0								
16 2									11		
16 30					9.3	6.5	7.0	9.4		17	P
17 0	5										
17 2									9		
17 30					9.6	7.1	7.0	9.2		16	P
18 0	120										
18 3									12		
18 30					9.6	6.7	6.5	8.7		17	P
19 0	5										
19 3									6		
19 30					9.3	6.4	7.0	8.7		16	P
20 0	CFD	13.5	71.0	3588							
20 0		12.5	71.0								
20 5									7		
20 30					8.8	6.5	7.8	8.9		16	P
21 0	5										
21 4									11		
21 30					8.0	6.7	6.6	10.0		15	P
22 0	95										
22 5									7		
22 30					9.2	6.1	6.5	9.7		19	P
23 0	5										
23 3									7		
23 30					9.3	6.1	6.1	8.6		16	P
23 55									5		
24 0	TC	12.5	70.9	3254							
TEST 07 — PERIOD 1.90 SECONDS — GENERATOR ANGLE 20 DEGREES											
0 0		9.3	71.0								
0 6									11		
0 25					11.4	13.0	13.0	14.2		36	P
0 55									12		
1 0	5										
1 4									9		
1 30					12.1	11.2	12.8			30	P
2 0	80			2064							
2 6									10		
2 30					12.4	10.6	12.3			29	P
3 0	5										
3 5									12		
3 30					11.1	11.6	12.8			29	P
4 0	CFD	9.5	71.0	1608							
4 0		11.0	71.0								
4 8									10		
4 30					9.3	10.3	12.7			31	P
5 0	5										
5 3									11		
5 30					9.1	9.6	12.7			32	P
6 0	85			1136							

TEST 07 CONT

RUN TIME HR MN	MINUTES STOPPED	WATER TEMP CELSIUS	WATER DEPTH CM	IMMERSED WEIGHT LBS	WAVE HEIGHT CM GAGE 1	GAGE 2	GAGE 3	GAGE 4A/4B	BREAKER ANGLE DEGREES	LONGSHORE CURRENT CM/S	BREAKER TYPE
6 6									10		
6 46					8.8	11.7	14.3			33	P
7 0	5										
7 4									10		
7 30					8.9	11.0	11.3			32	P
8 0	CFD	11.5	70.9	1216							
8 0		11.5	71.0								
8 3									9		
8 30					8.5	9.9	12.1	15.2		28	P
9 0	5										
9 4									12		
9 30					8.4	9.4	12.6	15.9		31	P
10 0	75										
10 5									12		
10 30					9.7	11.2	13.6	15.0		30	P
11 0	5										
11 4									10		
11 30					9.7	9.2	14.0	15.8		33	P
12 0	CFD	11.5	70.9	2234							
12 0		12.5	71.0								
12 1									11		
12 30					9.8	10.4	12.8			30	P
13 0	5										
13 5									12		
13 30					10.0	10.4	13.1			29	P
14 0	80										
14 3									11		
14 30					9.4	11.2	13.4			32	P
15 0	5										
15 4									11		
15 30					8.6	9.4	12.5			29	P
16 0	CFD	12.5	71.0	2016							
16 0		12.5	71.0								
16 3									12		
16 30					9.6	11.4	12.0			28	P
17 0	5										
17 4									9		
17 30					9.0	11.8	12.1			31	P
18 0	90										
18 5									11		
18 30					9.8	10.7	12.4			32	P
19 0	CFD										
19 0		12.5	71.0								
19 4									12		
19 30					8.6	9.9	12.6			28	P
20 0	CFD	12.5	71.0	2068							
20 0		12.5	71.0								
20 4									12		
20 30					9.3	10.1	12.6			25	P
21 0	5										
21 5									11		
21 30					10.0	11.8	12.3			28	P
22 0	100										
22 5									11		
22 30					9.7	10.8	11.6			28	P
23 0	5										
23 6									11		
23 30					8.8	10.2	12.4	15.3		28	P
23 51									13		
24 0	TC	12.5	71.0	1800							

TEST 08
PERIOD 1.90 SECONDS GENERATOR ANGLE 20 DEGREES

RUN TIME HR MN	MINUTES STOPPED	WATER TEMP CELSIUS	WATER DEPTH CM	IMMERSED WEIGHT LBS	GAGE 1	GAGE 2	GAGE 3	GAGE 4A/4B	BREAKER ANGLE DEGREES	LONGSHORE CURRENT CM/S	BREAKER TYPE
0 0		12.5	71.0								
0 5									9		
0 30					10.4	11.7	9.5	15.3		24	P
1 0	5										
1 4									9		
1 30					9.5	9.3	10.8	16.5		36	P
2 0	105										
2 6									12		
2 30					10.6	9.1	12.7	15.9		26	P
3 0	5										
3 3									11		
3 30					9.7	9.3	11.9	15.8		23	P
4 0	CFD	12.5	70.9	2304							
4 0		13.0	71.0								
4 4									12		
4 30					9.1	9.6	13.8	15.4		23	P
5 0	5										
5 5									13		
5 30					8.8	9.9	12.8	15.0		21	P+SP
6 0	90										
6 4									12		
6 30					8.2	11.5	12.4	15.0		26	P
7 0	5										
7 3									11		
7 30					7.2	10.6	11.8	13.9		26	P
8 0	CFD	12.5	70.9	1224							
8 0		14.0	71.0								
8 5									8		
8 30					7.6	11.2	11.8	15.3		19	P
9 0	5										
9 4									12		
9 30					8.5	10.4	12.8	15.9		20	P
10 0	80										
10 3									10		
10 30					9.4	12.6	12.3	15.5		15	P

TEST 08 CONT

RUN TIME HR MN	MINUTES STOPPED[1]	WATER TEMP CELSIUS	WATER DEPTH CM	IMMERSED WEIGHT LBS	WAVE HEIGHT CM GAGE 1	GAGE 2	GAGE 3	GAGE 4A/4B	BREAKER ANGLE DEGREES	LONGSHORE CURRENT CM/S	BREAKER TYPE
11 0	5										
11 4									11		
11 30					8.9	12.5	13.0	14.6		18	P
12 0	CFD	14.0	70.9	1062							
12 0		14.0	71.0								
12 3									10		
12 30					8.4	12.6	12.6	14.9		17	P
13 0	5										
13 3									10		
13 30					8.2	12.8	12.5	14.9		19	P
14 0	90										
14 4									15		
14 30					7.9	12.2	12.8	15.2		17	P
15 0	5										
15 2									14		
15 30					8.1	11.8	13.2	15.2		15	P
16 0	CFD	14.0	70.9	730							
16 0		15.0	71.0								
16 3									8		
16 30					8.6	11.1	13.2	15.3		19	P
17 0	5										
17 4									10		
17 30					8.2	11.1	14.7	15.5		17	P
18 0	100										
18 3									15		
18 30					8.0	11.7	13.8	14.7		20	P
19 0	5										
19 3									11		
19 30					9.3	11.0	14.0	15.0		17	P
20 0	CFD	15.0	70.9	600							
20 0		14.5	71.0								
20 5									13		
20 30					7.7	12.0	11.4	15.0		15	P
21 0	5										
21 4									10		
21 30					7.9	12.6	12.0	15.8		16	P
22 0	5										
22 5									12		
22 30					8.6	12.0	11.7	17.0		15	P
23 0	5										
23 3									10		
23 30					9.5	11.7	12.2	16.2		15	P
23 34									11		
24 0	TC	14.5	70.9	768							

TEST 09

PERIOD 1.50 SECONDS GENERATOR ANGLE 20 DEGREES

RUN TIME HR MN	MINUTES STOPPED	WATER TEMP CELSIUS	WATER DEPTH CM	IMMERSED WEIGHT LBS	GAGE 1	GAGE 2	GAGE 3	GAGE 4A/4B	BREAKER ANGLE DEGREES	LONGSHORE CURRENT CM/S	BREAKER TYPE
0 0		13.0	71.0								
0 4									15		
0 30					9.8	12.0	11.6	11.4			
1 0	5										
1 4									15		
1 30					11.7	9.4	10.8	10.5		35	SP-P
2 0	85										
2 4									13		
2 30					12.0	9.4	11.6	12.6		40	SP-P
3 0	5										
3 3									13		
3 30					12.1	10.5	11.0	12.0		39	SP-P
4 0	CFD	13.5	71.0	2114							
4 0		13.5	71.0								
4 3									15		
4 30					11.2	9.5	12.0	11.1		30	SP-P
5 0	5										
5 3									15		
5 30					11.7	9.6	11.1	11.9		32	SP-P
6 0	105										
6 4									14		
6 30					11.1	8.9	11.0	12.8		24	SP-P
7 0	5										
7 3									14		
7 30					10.6	9.6	10.4	13.4		27	SP-P
8 0	CFD	14.0	70.9	1920							
8 0		14.5	71.0								
8 2									14		
8 30					10.8	8.6	11.2	12.5		24	SP-P
9 0	5										
9 7									14		
9 30					11.0	9.1	10.8	12.8		27	SP-P
10 0	95										
10 4									15		
10 30					9.8	7.6	11.6	13.1		22	SP
11 0	5										
11 5									14		
11 30					10.2	8.6	10.2	12.5		27	SP
12 0	CFD	14.5	71.0	1930							
12 0		14.5	71.0								
12 5									14		
12 30					11.2	8.7	11.6	12.9		23	SP
13 0	5										
13 4									13		
13 30					11.8	9.4	11.5	13.2		31	SP
14 0	90										
14 3									15		
14 30					11.7	9.0	11.8	12.2		22	SP
15 0	5										
15 4									15		
15 30					10.8	9.9	10.7	13.7		27	SP
16 0	CFD	15.0	70.9	1504							
16 0		15.5	71.0								

TEST 09 CONT

RUN TIME HR MN	MINUTES STOPPED	WATER TEMP CELSIUS	WATER DEPTH CM	IMMERSED WEIGHT LBS	WAVE HEIGHT CM GAGE 1	GAGE 2	GAGE 3	GAGE 4A/4B	BREAKER ANGLE DEGREES	LONGSHORE CURRENT CM/S	BREAKER TYPE
16 4									13		
16 30					11.2		11.9	13.4		35	SP
17 0	5										
17 4									14		
17 30					11.3	10.0	11.5	13.1		24	SP
18 0	5										
18 3									16		
18 30					11.4	10.1	11.8	11.7		19	SP
19 0	5										
19 4									17		
19 30					12.1	9.0	11.4	11.0		16	SP
20 0	CPD	15.5	71.0	1478							
20 0		15.5	71.0								
20 5									15		
20 30					11.5	7.8	11.6	12.0		24	SP
21 0	5										
21 4									15		
21 30					11.4	8.3	11.6	10.1		36	SP
22 0	CPD	15.5	71.0	804							
22 0		15.5	71.0								
22 4									15		
22 30					11.1	9.8	12.1	10.8		16	SP
23 0	5										
23 5									15		
23 30					12.2	10.2	12.2	10.5		21	SP
23 54									16		
24 0	TC	15.5	71.0	804							

TEST XV

PERIOD 1.90 SECONDS GENERATOR ANGLE 20 DEGREES

RUN TIME HR MN	MINUTES STOPPED	WATER TEMP CELSIUS	WATER DEPTH CM	IMMERSED WEIGHT LBS	GAGE 1	GAGE 2	GAGE 3	GAGE 4A/4B	BREAKER ANGLE DEGREES	LONGSHORE CURRENT CM/S	BREAKER TYPE
0 0		19.7	71.0								
0 18									11		
0 30					14.4	18.3	17.1	12.9		26	P
1 0	5										
1 5									14		
1 30					15.3	18.0	18.3	13.8		27	P
2 0	90										
2 4									14		
2 30					14.3	17.1	17.6	15.3		26	P
3 0	5										
3 4									14		
3 30					15.3	18.2	18.6	15.2		27	P
4 0	CPD	18.5	70.9								
4 0		19.3	71.0								
4 3									16		
4 30					14.7	18.0	18.3	14.1		34	P
5 0	5										
5 4									16		
5 30					13.8	17.4	17.0	16.2		27	P
6 0	100										
6 4									16		
6 30					15.3	17.7	19.2	15.9		26	P
7 0	5										
7 3									17		
7 30					15.6	17.9	18.9	16.2		26	P
8 0	CPD	18.9	71.0								
8 0		19.2	71.0								
8 2									16		
8 30					14.7	18.5	18.3	17.7		30	P
9 0	5										
9 3									15		
9 30					14.4	18.2	17.4	18.3		32	P
10 0	5										
10 4									15		
10 30					13.8	18.3	17.1	19.2		33	P
11 0	5										
11 4									16		
11 30					14.7	17.9	18.0	18.2		32	P
12 0	CPD	18.5	70.9	9756							
12 0		19.4	71.0								
12 4									15		
12 30					15.3	17.3	17.1	16.8		31	P
13 0	5										
13 3									18		
13 30					14.4	18.0	16.4	16.4		32	P
14 0	70										
14 2									16		
14 30					15.0	21.0	17.4	17.1		28	P
15 0	5										
15 4									15		
15 30					13.7	19.5	15.5	18.3		33	P
16 0	CPD	19.0	70.9	3528							
16 0		18.9	71.0								
16 2									15		
16 30					14.1	19.2	16.5	17.4		28	P
17 0	5										
17 4									14		
17 30					14.4	18.8	19.1	19.2		25	P
18 0	120										
18 4									16		
18 30					14.1	19.8	19.2	18.6		26	P
19 0	5										
19 5									16		
19 30					13.7	20.7	16.8	19.7		25	P
20 0	CPD	18.3	70.8	3556							
20 0		18.2	71.0								
20 3									16		
20 30					13.5	19.5	17.1	18.5		27	P
21 0	5										
21 3									16		

TEST 10 CONT

RUN TIME HR MN	MINUTES STOPPED[1]	WATER TEMP CELSIUS	WATER DEPTH CM	IMMERSED WEIGHT LBS	WAVE HEIGHT CM GAGE 1	GAGE 2	GAGE 3	GAGE 4A/4B	BREAKER ANGLE DEGREES	LONGSHORE CURRENT CM/S	BREAKER TYPE
21 30					14.3	19.2	17.0	18.2		37	P
22 0	85										
22 8									17		
22 30					13.7	18.5	15.2	17.9		37	P
23 0	5										
23 3									16		
23 30					14.6	18.0	16.2	18.5		34	P
23 53									15		
24 0	TC	18.2	70.9	3760							
TEST 11 PERIOD 2.35 SECONDS GENERATOR ANGLE 00 DEGREES											
0 0		20.7	71.0								
0 5									-7		
0 30					10.2	9.0	7.8	14.0		-9	P
1 0	5										
1 2									-8		
1 30					9.7	8.5	7.6	14.4		-7	P
2 0	40										
2 2									-9		
2 35										0	P
2 53					9.4	5.2	9.6	13.8			
3 0	15										
3 3									-3		
3 30					9.2	4.7	10.0	14.9		0	P
4 0	CFD	20.8		642							
4 0		21.7	71.0								
4 9									-5		
4 33					9.1	5.2	9.6	13.8		0	P
5 0	5										
5 5									-3		
5 40					9.8	4.4	9.1	12.5		0	P
6 0	11										
6 4									-5		
6 30					10.2	4.9	8.9	14.6		0	P
7 0	5										
7 3									-5		
7 20					9.9	5.0	8.7	12.9		0	P
8 0	CFD	22.0	70.9	290							
8 0		21.8	71.0								
8 4									-4		
8 30					9.6	5.1	8.7	14.4		0	P
9 0	5										
9 5									-3		
9 30					9.1	5.1	9.9	13.5		0	P
10 0	5										
10 4									-4		
10 30					9.0	4.6	9.0	13.4		0	P
11 0	10										
11 3									-4		
11 30					9.6	5.2	8.7	14.0		3	P
12 0	CFD	20.8	70.9	70							
12 0		20.6	71.0								
12 5									-4		
12 35										0	P
12 46					9.6	7.4	10.0	11.3			
13 0	5										
13 4									-4		
13 30					9.7	4.8	8.6	13.7		0	P
14 0	5										
14 3									-3		
14 30					9.2	5.0	9.2	12.9		2	P
15 0	5										
15 3									-4		
15 30					9.4	5.2	8.6	13.2		0	P
16 0	CFD	20.0	70.9	310							
16 0		19.9	71.0								
16 3									-4		
16 30					9.2	5.0	9.1	14.1		2	P
17 0	7										
17 2									-6		
17 30					9.8	4.9	9.0	12.8		2	P
18 0	8										
18 4									-5		
18 30					9.5	5.2	9.2	12.6		2	P
19 0	5										
19 3									-3		
19 30					9.2	4.6	9.6	13.5		1	P
20 0	CFD	19.7	71.0	215							
20 0		20.4	71.0								
20 3									-4		
20 30					9.6	5.1	8.2	12.8		2	P
21 0	5										
21 4									-4		
21 33					9.6	4.4	9.0	12.5		0	P
22 0	5										
22 5									-4		
22 30					9.9	4.5	8.6	12.9		0	P
23 0	9										
23 1									-5		
23 30					9.1	5.4	8.2	12.8		0	P
23 59									-4		
24 0	TC	20.2	70.9	206							
TEST 12 PERIOD 2.35 SECONDS GENERATOR ANGLE 30 DEGREES											
0 0		23.4	71.0								
0 13	CFD										
0 13		23.3	71.0								
0 19									21		

TEST 12 CONT

RUN TIME HR MN	MINUTES STOPPED	WATER TEMP CELSIUS	WATER DEPTH CM	IMMERSED WEIGHT LBS	WAVE HEIGHT CM GAGE 1	GAGE 2	GAGE 3	GAGE 4A/4B	BREAKER ANGLE DEGREES	LONGSHORE CURRENT CM/S	BREAKER TYPE
0 30					9.7	5.3	7.3	9.9		30	P
1 0	5										
1 5									21		
1 30					9.5	5.4	8.1	9.6		25	P
2 0	25										
2 4									22		
2 30					10.3	4.5	6.7	4.5		23	P
3 0	10										
3 1									15		
3 30					10.6	4.7	6.1	8.6		24	P
4 0	CFD	22.9	71.0	3783							
4 0		22.8	71.0								
4 5									18		
4 30					10.3		7.5	11.2		25	P
5 0	5										
5 8									21		
5 30					10.3		6.6	8.4		21	P
6 0	55										
6 4									24		
6 30					9.5		6.9	9.4		28	P
7 0	5										
7 3									17		
7 30					10.3		6.2	8.3		28	P
8 0	CFD	22.9	70.9	5437							
8 0		23.0	71.0								
8 4									21		
8 30					9.6	5.7	6.7	10.1		29	P
9 0	5										
9 2									19		
9 30					11.0	4.7	6.1	9.6		25	P
10 0	5										
10 4									17		
10 30					10.5	4.9	6.5	9.8		29	P
11 0	85										
11 2									23		
11 30					10.3	5.2	6.1	9.2		29	P
12 0	CFD	23.1	70.9	5402							
12 0		23.1	71.0								
12 2									22		
12 30					11.3	4.3	6.0	8.6		25	P
13 0	5										
13 4									16		
13 30					10.1	4.9	6.1	8.6		23	P
14 0	5										
14 3									18		
14 30					11.4	4.9	5.9	9.1		29	P
15 0	70										
15 3									22		
15 30					9.9	5.3	6.0	8.8		33	P
16 0	CFD	23.4	70.9	5626							
16 0		23.6	71.0								
16 5									22		
16 30					9.3	6.4	6.9	8.4		29	P
17 0	10										
17 8									22		
17 30					9.2	6.1	6.1	8.2		37	P
18 0	30										
18 3									18		
18 30					9.6	5.6	6.2	8.2		32	P
19 0	92										
19 14									21		
19 30					9.9	6.0	6.3	9.6		40	P
20 0	CFD	23.9	71.0	5724							
20 0		22.6	71.0								
20 3									21		
20 30					9.7	6.5	7.3	10.1		33	P
21 0	10										
21 9									20		
21 30					9.5	5.8	7.0	11.0		33	P
22 0	15										
22 5									18		
22 30					9.1	4.8	6.2	10.3		32	P
23 0	10										
23 3									19		
23 30					9.5	5.0	6.2	9.6		29	P
23 50									20		
24 0	TC	22.3	71.0	5775							

TEST 13

PERIOD 3.00 SECONDS GENERATOR ANGLE 30 DEGREES

RUN TIME HR MN	MINUTES STOPPED	WATER TEMP CELSIUS	WATER DEPTH CM	IMMERSED WEIGHT LBS	GAGE 1	GAGE 2	GAGE 3	GAGE 4A/4B	BREAKER ANGLE DEGREES	LONGSHORE CURRENT CM/S	BREAKER TYPE
0 0		22.7	71.0								
0 4									15		
0 30					6.6	7.6	7.1	7.1		6	SG
1 0	5										
1 4									15		
1 30					6.7	8.0	7.3	6.4		8	SG
2 0	10										
2 3									18		
2 43					6.1	7.6	7.0	9.1		8	SG
3 0	5										
3 3									16		
3 30					6.2	7.8	6.7	9.0		8	SG
4 0	CFD	23.1	70.8	4239							
4 0		22.9	71.0								
4 5									19		
4 30					7.2	7.0	5.9	11.9		8	SG
5 0	10										
5 5									19		
5 30					6.7	6.8	6.1	11.6		7	SG

TEST 13 CONT

RUN TIME HH	MN	MINUTES STOPPED	WATER TEMP CELSIUS	WATER DEPTH CM	IMMERSED WEIGHT LBS	WAVE HEIGHT CM GAGE 1	GAGE 2	GAGE 3	GAGE 4A/4B	BREAKER ANGLE DEGREES	LONGSHORE CURRENT CM/S	BREAKER TYPE
6	0	10										
6	5									12		
6	32					6,8	6,9	6,0	11,9		8	SG
7	0	10										
7	4									13		
7	30					7,1	6,8	6,4	11,1		9	SG
8	0	CFD	23,1	71,0	4227							
8	0		23,6	71,0								
8	3									15		
8	30					6,3	7,3	7,0	11,7		9	SG
9	0	15										
9	2									15		
9	30					6,2	7,0	7,0	12,2		8	SG
10	0	CFD	23,8	70,9	1861							
10	0		23,7	71,0								
10	2									20		
10	30					6,6	6,6	6,2	10,6		6	SG
11	0	10										
11	2									14		
11	30					7,2	6,5	6,8	9,9		9	SG
12	0	10										
12	5									16		
12	30					7,1	6,4	6,9	9,4		10	SG
13	0	10										
13	4									16		
13	30					7,0	6,6	6,0	9,1		8	SG
14	0	CFD	23,5	71,0	3566							
14	0		23,5	71,0								
14	4									18		
14	30					7,1	6,8	6,5	9,2		9	SG
15	0	10										
15	3									16		
15	30					6,8	6,8	6,4	9,6		7	SG
16	0	10										
16	2									15		
16	30					6,5	6,7	5,8	8,6		7	SG
17	0	10										
17	6									12		
17	30					6,2	6,7	6,8	10,9		7	SG
18	0	CFD	22,9	71,0	3633							
18	0		22,8	71,0								
18	5									16		
18	30					6,8	7,0	6,1	6,4		5	SG
19	0	20										
19	5									18		
19	30					6,5	7,1	6,2	6,5		5	SG
20	0	60										
20	5									14		
20	30					5,9	7,8	7,3	7,5		8	SG
21	0	10										
21	5									12		
21	30					5,8	8,2	7,2	8,0		4	SG
22	0	CFD	23,1	71,0	3789							
22	0			71,0								
22	5									13		
22	30					5,7	7,6	6,5	6,8		5	SG
23	0	5										
23	3									11		
23	30					6,2	7,9	7,7	7,3		8	SG
23	55									11		
24	0	TC	23,1	71,0	1080							
TEST 14												
PERIOD 3,00 SECONDS												
GENERATOR ANGLE 30 DEGREES												
0	0		20,5	71,0								
0	10									27		
0	30					13,2	17,4	14,7	17,0		33	P
1	0	10										
1	2									28		
1	30					15,0	16,8	15,8	16,8		31	P
2	0	40										
2	6									20		
2	30					15,6	14,7	15,3	15,8		27	P
3	0	32										
3	2									23		
3	30					15,6	16,2	15,6	16,8		40	P
4	0	CFD	20,4	70,9	10356							
4	0		20,0	71,0								
4	4									26		
4	30					14,1	16,8	11,4	19,2		29	P
5	0	10										
5	2									29		
5	30					14,4	17,0	12,6	18,8		21	P
6	0	10										
6	4									29		
6	30					15,0	18,2	12,0	18,6		21	P
7	0	60										
7	6									31		
7	30					15,6	17,7	12,2	18,6		[illegible]	P
8	0	CFD	19,8	70,9	10036							
8	0		19,8	71,0								
8	3									31		
8	30					14,0	18,3	11,4	19,2		19	P
9	0	10										
9	5									29		
9	30					14,7	16,8	12,0	19,5		17	P
10	0	15										
10	3									30		
10	30					14,7	18,2	11,5	19,5		20	P
11	0	75										

TEST 18 CONT

RUN TIME HR MN	MINUTES STOPPED	WATER TEMP CELSIUS	WATER DEPTH CM	IMMERSED WEIGHT LBS	WAVE HEIGHT CM GAGE 1	GAGE 2	GAGE 3	GAGE 4A/4B	BREAKER ANGLE DEGREES	LONGSHORE CURRENT CM/S	BREAKER TYPE
11 3									30		
11 30					14.4	16.8	12.3	18.6		16	P
12 0	CFD	19.4	70.9	10641							
12 0		19.6	71.0								
12 3									32		
12 30					14.1	16.1	13.4	17.6		20	P
13 0	10										
13 8									30		
13 30					14.6	15.0	13.5	16.8		22	P
14 0	15										
14 6									32		
14 30					14.6	15.6	13.2	17.2		19	P
14 45	75										
15 0	[illegible]										
15 4									29		
15 30					14.7	15.2	13.5	16.8		19	P
16 0	CFD	19.1	71.0	10824							
16 0		19.5	71.0								
16 4									30		
16 30					13.8	16.8	12.8	17.9		[illegible]	P
17 0	10										
17 4									30		
17 30					15.8	15.9	12.6	17.0		23	P
18 0	15										
18 3									32		
18 30					14.1	17.7	13.5	16.8		21	P
19 0	75										
19 3									33		
19 30					14.3	16.8	12.8	17.1		19	P
20 0	CFD	19.2	70.9	10170							
20 0		18.2	71.0								
20 3									33		
20 30					13.2	14.4	12.3	19.1		22	P
21 0	15										
21 3									32		
21 30					15.2	17.4	12.2	18.6		22	P
21 50	25										
21 50											
22 0	5										
22 3									28		
22 40					14.3	16.2	12.0	18.8		21	P
23 0	85										
23 4									31		
23 38					15.0	15.0	12.3	17.6		22	P
23 50									31		
24 0	TC	17.4	70.9	11954							

TEST [illegible]

PERIOD 1.90 SECONDS GENERATOR ANGLE 30 DEGREES

RUN TIME HR MN	MINUTES STOPPED	WATER TEMP CELSIUS	WATER DEPTH CM	IMMERSED WEIGHT LBS	WAVE HEIGHT CM GAGE 1	GAGE 2	GAGE 3	GAGE 4A/4B	BREAKER ANGLE DEGREES	LONGSHORE CURRENT CM/S	BREAKER TYPE
0 0			71.0								
0 6									19		
0 30					13.8	18.0	13.2	18.0		44	SP-P
1 0	5										
1 4									16		
1 30					13.8	17.6	14.6	18.3		36	P
2 0	5										
2 6									16		
2 20	5										
2 30					12.6	17.6	15.3	18.3		40	SP-P
3 0	155										
3 5									20		
3 30					13.7	16.2	15.3	18.3		40	P
4 0	CFD		71.0	7426							
4 0			71.0								
4 5									18		
4 30					14.0	15.8	13.2	19.5		40	P-SP
5 0	5										
5 4									16		
5 30					13.4	17.0	12.6	19.2		35	P-SP
6 0	5										
6 4									17		
6 30					13.4	16.4	13.5	18.8		38	P-SP
7 0	90										
7 3									19		
7 30					14.6	16.8	13.4	19.4		36	P-SP
8 0	CFD		71.0	6884							
8 0		18.0	71.0								
8 3									18		
8 30					13.2	17.0	14.6	18.9		36	P-SP
8 56	15										
8 56											
9 0	5										
9 3									19		
9 30					13.9	16.8	13.8	19.1		35	P-SP
10 0	5										
10 4									19		
10 30					13.8	16.4	14.4	19.5		40	P-SP
11 0	90										
11 4									20		
11 30					13.4	16.8	14.3	18.6		40	P-SP
12 0	CFD	16.8	71.0	7929							
12 0		15.5	71.0								
12 8									19		
12 30					12.8	17.0		19.6		40	P-SP
13 0	5										
13 3									19		
13 30					13.2	15.9		19.4		44	P-SP
14 0	5										
14 3									20		
14 30					14.4	17.0		19.2		40	P-SP

TEST 15 CONT

RUN TIME HR	RUN TIME MN	MINUTES STOPPED/	WATER TEMP CELSIUS	WATER DEPTH CM	IMMERSED WEIGHT LBS	WAVE HEIGHT CM GAGE 1	GAGE 2	GAGE 3	GAGE 4A/4B	BREAKER ANGLE DEGREES	LONGSHORE CURRENT CM/S	BREAKER TYPE
15	0	55										
15	4									18		
15	30					13.2	18.3		18.9		40	P-SP
16	0	CPL	15.5	70.9	8622							
16	0		16.0	71.0								
16	5									18		
16	30					12.5	16.8	12.8	18.6		40	P-SP
17	0	10										
17	3									18		
17	30					12.6	16.8	10.7	19.7		41	P-SP
18	0	10										
18	3									21		
18	30					13.0	15.0	12.2	20.1		43	P-SP
19	0	115										
19	3									18		
19	30					13.1	17.3	12.3	20.6		43	P-SP
20	0	CPD	16.5	70.9	9456							
20	0		17.0	71.0								
20	2									16		
20	30					13.1	15.8		20.1		39	P
21	0	10										
21	3									19		
21	30					12.0	16.5		20.6		40	P
22	0	20										
22	6									20		
22	30					12.8	18.3		20.9		44	P
23	0	80										
23	4									21		
23	30					13.2	15.6		19.5		41	P
23	53									21		
24	0	TC	16.5	70.9	9220							

APPENDIX B

BEACH SURVEY DATA

TEST 1

RANGE 1.5		RANGE 2.0		RANGE 3.0		RANGE 4.0		RANGE 5.0		RANGE 6.0		RANGE 7.0		RANGE 7.6	
STA (M)	ELEV (M)	STA (M)	ELEV (M)	STA (M)	ELEV (M)	STA (M)	ELEV (M)	STA (M)	ELEV (M)	STA (M)	ELEV (M)	STA (M)	ELEV (M)	STA (M)	ELEV (M)
0.00	.275	0.00	.275	0.00	.280	0.00	.275	0.00	.280	0.00	.270	0.00	.280	0.00	.275
1.37	.150	1.39	.135	1.18	.160	1.31	.135	1.40	.135	1.40	.140	1.30	.130	.85	.190
1.62	.110	1.75	.105	1.49	.120	1.80	.105	1.83	.140	1.85	.110	1.85	.105	1.30	.150
2.12	.145	2.13	.120	1.71	.090	2.03	.120	2.62	-.010	2.53	-.010	2.40	-.005	1.58	.115
2.78	-.005	2.85	-.005	2.19	.115	2.70	-.010	3.20	-.120	3.17	-.135	2.90	-.100	2.40	-.010
3.28	-.085	3.38	-.085	2.80	-.005	2.94	-.050	3.60	-.110	3.45	-.170	3.34	-.185	3.00	-.085
3.63	-.150	3.68	-.160	3.15	-.050	3.12	-.085	4.19	-.160	3.70	-.085	3.63	-.100	3.20	-.090
3.89	-.080	3.90	-.085	3.33	-.115	3.30	-.090	4.90	-.240	4.73	-.230	4.40	-.185	4.34	-.175
4.34	-.135	4.64	-.165	3.67	-.090	3.70	-.115	5.89	-.255	6.20	-.300	5.29	-.235	4.85	-.215
5.05	-.225	5.49	-.240	4.80	-.195	4.77	-.215	6.94	-.340	7.22	-.350	6.55	-.325	5.23	-.240
6.03	-.270	6.10	-.260	6.03	-.250	5.88	-.240	8.04	-.405	8.23	-.445	7.91	-.385	5.66	-.240
6.60	-.310	6.70	-.305	6.48	-.300	6.82	-.330	9.17	-.490	9.03	-.490	8.90	-.495	6.63	-.305
7.24	-.340	7.24	-.325	7.19	-.325	7.89	-.385	9.97	-.585	9.97	-.595	10.10	-.610	7.33	-.330
7.85	-.390	7.89	-.380	7.89	-.385	8.83	-.485	11.00	-.675	11.08	-.685	11.10	-.670	7.98	-.380
8.12	-.410	8.23	-.405	8.25	-.425	9.95	-.575	11.93	-.720	11.93	-.715	11.93	-.715	9.48	-.520
8.50	-.450	8.55	-.445	8.60	-.455	11.09	-.670							10.10	-.580
8.84	-.480	8.80	-.470	8.84	-.475	11.93	-.720							11.03	-.670
9.23	-.505	9.33	-.520	9.20	-.510									11.93	-.715
10.20	-.595	10.57	-.625	10.30	-.605										
11.25	-.675	11.93	-.715	11.93	-.720										
11.93	-.720														

TEST 2 (after 25 hours)

RANGE 1.5		RANGE 2.0		RANGE 3.0		RANGE 4.0		RANGE 5.0		RANGE 6.0		RANGE 7.0		RANGE 7.6	
STA (M)	ELEV (M)	STA (M)	ELEV (M)	STA (M)	ELEV (M)	STA (M)	ELEV (M)	STA (M)	ELEV (M)	STA (M)	ELEV (M)	STA (M)	ELEV (M)	STA (M)	ELEV (M)
0.00	.295	0.00	.300	0.00	.315	0.60	.295	0.00	.290	0.00	.285	0.00	.295	0.00	.300
1.74	.115	1.81	.105	1.95	.095	1.58	.150	1.49	.145	1.51	.155	1.34	.140	1.08	.150
2.15	.150	2.16	.120	2.97	-.005	1.94	.135	1.86	.160	1.74	.160	1.40	.115	2.59	-.005
3.05	-.005	3.05	0.000	3.17	-.040	2.58	.005	2.62	-.005	2.59	0.000	2.58	-.005	3.15	-.075
3.54	-.080	3.37	-.060	3.29	-.075	3.14	-.100	2.99	-.110	3.08	-.115	3.08	-.090	3.60	-.090
3.75	-.130	3.60	-.100	3.44	-.100	3.43	-.160	3.40	-.200	3.47	-.200	3.44	-.190	5.00	-.225
3.93	-.090	3.87	-.080	3.66	-.065	3.61	-.095	3.79	-.100	3.81	-.095	3.90	-.100	6.74	-.310
4.56	-.160	4.13	-.115	4.33	-.135	4.48	-.170	4.51	-.180	4.45	-.180	4.47	-.170	8.03	-.375
5.93	-.255	4.95	-.135	5.59	-.230	5.38	-.235	5.67	-.240	5.43	-.270	5.88	-.265	9.19	-.500
7.01	-.320	5.58	-.245	6.98	-.315	6.78	-.325	6.95	-.345	6.66	-.340	6.93	-.330	10.67	-.625
8.69	-.470	6.68	-.295	8.32	-.450	8.02	-.400	8.23	-.425	8.35	-.455	8.20	-.410	12.04	-.710
10.06	-.580	7.88	-.380	9.53	-.525	9.48	-.520	9.62	-.535	9.48	-.520	9.45	-.520		
11.44	-.675	9.48	-.525	10.70	-.640	10.73	-.635	10.82	-.660	10.90	-.660	10.73	-.645		
12.01	-.710	10.76	-.635	11.84	-.715	11.87	-.715	11.87	-.715	11.98	-.710	11.81	-.705		
		11.98	-.705												

TEST 2 (after 50 hours)

RANGE 1.5		RANGE 2.0		RANGE 3.0		RANGE 4.0		RANGE 5.0		RANGE 6.0		RANGE 7.0		RANGE 7.6	
STA (M)	ELEV (M)	STA (M)	ELEV (M)	STA (M)	ELEV (M)	STA (M)	ELEV (M)	STA (M)	ELEV (M)	STA (M)	ELEV (M)	STA (M)	ELEV (M)	STA (M)	ELEV (M)
0.00	.295	0.00	.290	0.00	.310	0.00	.295	0.00	.285	0.00	.285	0.00	.290	0.00	.300
.58	.180	1.47	.130	1.56	.145	.89	.195	.92	.185	.90	.205	.97	.190	1.24	.160
2.09	.155	2.12	.130	1.78	.120	1.63	.140	1.38	.145	1.41	.160	1.48	.140	1.75	.115
2.37	.185	2.91	-.005	2.14	.105	1.82	.145	1.75	.160	1.85	.145	2.20	.055	1.85	.075
2.92	-.005	3.22	-.050	2.79	-.005	2.17	.090	1.86	.120	2.53	0.000	2.42	.005	2.45	-.005
3.19	-.050	3.52	-.100	3.10	-.060	2.60	-.005	2.26	.085	2.90	-.075	2.92	-.085	2.83	-.045
3.38	-.075	3.74	-.145	3.36	-.110	2.96	-.060	2.52	-.005	3.12	-.130	3.27	-.145	3.18	-.100
3.60	-.120	3.92	-.080	3.68	-.070	3.17	-.100	2.92	-.045	3.40	-.145	3.47	-.160	3.50	-.085
3.81	-.075	4.15	-.115	5.03	-.230	3.36	-.080	3.10	-.085	3.72	-.080	3.78	-.100	4.75	-.200
4.19	-.130	5.08	-.235	6.94	-.340	4.40	-.160	3.32	-.130	4.43	-.195	4.44	-.165	5.69	-.240
5.21	-.245	6.08	-.275	9.51	-.545	5.46	-.260	3.98	-.210	5.44	-.240	5.76	-.245	7.28	-.335
6.74	-.325	7.25	-.350	11.80	-.715	6.97	-.355	4.32	-.160	6.88	-.370	7.26	-.350	8.50	-.445
8.63	-.490	10.10	-.595			9.49	-.520	6.17	-.300	8.50	-.495	8.53	-.470	10.04	-.570
10.44	-.605	11.85	-.705			11.78	-.715	9.66	-.715	10.04	-.595	10.08	-.590	11.94	-.715
11.80	-.700									11.85	-.705	11.88	-.705		

TEST 3

RANGE 1.5		RANGE 2.0		RANGE 3.0		RANGE 4.0		RANGE 5.0		RANGE 6.0		RANGE 7.0		RANGE 7.6	
STA (M)	ELEV (M)	STA (M)	ELEV (M)	STA (M)	ELEV (M)	STA (M)	ELEV (M)	STA (M)	ELEV (M)	STA (M)	ELEV (M)	STA (M)	ELEV (M)	STA (M)	ELEV (M)
0.00	.270	0.00	.310	0.00	.315	0.60	.295	0.00	.295	0.00	.290	0.00	.295	0.00	.310
1.86	.085	1.80	.100	1.68	.110	1.65	.115	1.49	.130	1.46	.145	1.54	.130	1.47	.130
2.50	-.010	2.36	0.000	1.72	.080	2.27	-.005	2.02	.060	1.51	.095	1.55	.080	1.88	.105
2.80	-.045	3.78	-.105	2.24	0.000	3.20	-.080	2.16	.060	1.66	.085	1.90	-.005	1.90	0.000
3.20	-.090	4.03	-.150	3.21	-.065	3.41	-.105	2.46	0.000	1.71	.080	3.75	-.175	2.98	-.110
3.50	-.125	4.39	-.105	3.48	-.080	3.67	-.085	3.19	-.075	2.09	0.000	3.95	-.195	3.92	-.195
3.75	-.120	5.73	-.270	3.66	-.110	4.96	-.230	3.33	-.115	3.40	-.090	4.32	-.125	4.39	-.145
4.18	-.190	6.08	-.275	4.02	-.095	5.50	-.260	3.66	-.065	3.66	-.130	5.33	-.240	5.29	-.215
4.60	-.120	6.62	-.260	4.36	-.175	6.23	-.260	4.34	-.170	3.93	-.090	6.07	-.245	6.61	-.265
5.07	-.200	7.62	-.295	5.06	-.230	6.58	-.265	4.78	-.200	5.11	-.230	6.74	-.260	7.79	-.360
5.45	-.270	9.45	-.505	5.37	-.245	6.88	-.240	5.29	-.235	5.93	-.260	7.22	-.290	9.50	-.520
5.95	-.280	10.77	-.635	6.51	-.255	7.90	-.285	5.86	-.215	6.55	-.255	8.36	-.405	11.92	-.705
6.70	-.265	11.95	-.710	7.39	-.260	9.26	-.480	6.57	-.270	6.99	-.245	9.23	-.505		
7.60	-.285			8.08	-.310	9.77	-.545	6.97	-.230	7.59	-.295	11.94	-.705		
8.20	-.335			8.54	-.375	11.94	-.705	7.55	-.300	8.00	-.300				
9.08	-.435			9.12	-.470			8.08	-.290	8.85	-.455				
10.03	-.550			10.66	-.625			8.73	-.395	9.75	-.555				
11.07	-.630			11.85	-.710			9.50	-.515	11.98	-.705				
11.98	-.690							9.99	-.575						
								11.95	-.705						

TEST 4

RANGE 1.5

STA (M)	ELEV (M)
0.00	.280
1.10	.155
1.36	.145
1.66	.105
2.11	.110
2.77	0.000
3.09	-.080
3.35	-.055
4.34	-.170
4.65	-.110
5.87	-.225
7.00	-.285
8.82	-.465
10.26	-.575
11.73	-.705
11.98	-.715

RANGE 2.0

STA (M)	ELEV (M)
0.00	.285
1.02	.125
1.61	.095
1.87	.095
2.10	.080
2.29	.085
2.71	-.005
3.04	-.075
3.29	-.060
4.28	-.150
4.67	-.105
5.44	-.185
6.45	-.230
7.47	-.325
8.35	-.410
9.20	-.505
9.95	-.550
10.75	-.625
11.63	-.705
11.98	-.715

RANGE 3.0

STA (M)	ELEV (M)
0.00	.275
.67	.235
1.41	.125
1.61	.090
1.83	.100
2.45	-.005
3.69	-.090
4.14	-.115
4.71	-.115
5.37	-.220
6.10	-.200
6.80	-.245
7.63	-.295
8.62	-.435
9.49	-.525
10.34	-.595
11.97	-.715

RANGE 4.0

STA (M)	ELEV (M)
0.00	.285
1.34	.135
1.44	.105
1.71	.105
1.87	.090
2.40	-.005
2.65	-.045
2.84	-.065
3.19	-.105
3.66	-.090
3.94	-.095
4.35	-.170
4.70	-.140
4.97	-.160
5.17	-.170
5.49	-.225
6.14	-.220
6.48	-.215
6.85	-.275
7.31	-.285
7.73	-.305
8.20	-.335
8.48	-.415
9.00	-.480
9.52	-.540
10.20	-.590
11.98	-.700

RANGE 5.0

STA (M)	ELEV (M)
0.00	.295
.68	.230
1.45	.115
2.07	.050
2.43	-.005
2.95	-.060
3.50	-.120
4.07	-.130
4.60	-.190
4.95	-.170
5.72	-.250
6.94	-.270
7.45	-.260
7.88	-.230
8.63	-.440
9.50	-.545
9.92	-.580
10.40	-.620
11.01	-.675
11.98	-.705

RANGE 6.0

STA (M)	ELEV (M)
0.00	.300
1.34	.125
1.35	.100
1.77	.060
2.14	-.005
2.91	-.075
3.42	-.125
3.61	-.165
3.91	-.095
4.21	-.135
4.65	-.200
5.15	-.200
5.75	-.230
7.18	-.260
7.20	-.255
7.81	-.300
8.57	-.430
9.15	-.455
9.76	-.615
10.38	-.670

RANGE 7.0

STA (M)	ELEV (M)
0.00	.285
1.25	.135
1.28	.075
1.85	.015
2.00	0.000
2.86	-.090
3.10	-.135
3.46	-.095
3.76	-.145
4.18	-.165
4.65	-.170
5.17	-.225
6.05	-.230
6.72	-.285
7.27	-.295
7.85	-.325
8.49	-.425
9.00	-.460
9.56	-.515
9.86	-.540
10.20	-.585
10.82	-.645
11.98	-.700

RANGE 7.6

STA (M)	ELEV (M)
0.00	.310
1.20	.170
1.24	.115
1.67	0.000
2.21	-.045
3.20	-.070
3.47	-.140
4.24	-.185
4.73	-.175
5.23	-.235
6.10	-.230
7.00	-.295
8.08	-.380
9.55	-.505
11.98	-.700

TEST 5

RANGE 1.5

STA (M)	ELEV (M)
0.00	.275
.95	.185
.96	.170
1.39	.185
2.07	.105
2.73	-.020
3.78	-.245
4.68	-.205
5.47	-.205
6.15	-.270
6.85	-.300
7.88	-.330
8.75	-.470
11.70	-.705
11.84	-.715

RANGE 2.0

STA (M)	ELEV (M)
0.00	.275
.90	.185
1.52	.225
2.72	-.005
4.00	-.235
4.85	-.200
5.58	-.230
6.11	-.270
6.94	-.305
7.62	-.350
8.85	-.475
11.22	-.675
11.98	-.715

RANGE 3.0

STA (M)	ELEV (M)
0.00	.260
.98	.175
1.85	.155
2.76	-.005
4.16	-.220
4.98	-.170
6.14	-.285
6.80	-.310
7.49	-.310
7.98	-.365
9.43	-.520
11.36	-.685
11.96	-.715

RANGE 4.0

STA (M)	ELEV (M)
0.00	.280
.98	.175
1.42	.190
1.74	.185
2.80	-.010
3.45	-.105
4.14	-.220
4.91	-.175
5.89	-.300
6.22	-.290
7.47	-.310
8.80	-.465
9.51	-.535
11.55	-.700
11.97	-.715

RANGE 5.0

STA (M)	ELEV (M)
0.00	.265
.90	.190
1.62	.235
2.74	-.010
3.65	-.225
4.16	-.220
4.76	-.165
5.40	-.245
6.87	-.330
7.65	-.310
8.50	-.455
8.98	-.470
10.57	-.635
11.96	-.705

RANGE 6.0

STA (M)	ELEV (M)
0.00	.280
.85	.190
1.24	.205
2.65	-.010
3.24	-.090
4.00	-.220
4.88	-.190
5.74	-.260
6.80	-.330
7.68	-.325
8.23	-.370
8.80	-.455
10.12	-.590
11.50	-.665
11.97	-.705

RANGE 7.0

STA (M)	ELEV (M)
0.00	.275
.97	.185
1.14	.185
2.53	-.010
3.26	-.100
3.88	-.190
4.84	-.185
6.10	-.240
6.76	-.310
7.30	-.295
8.08	-.330
9.27	-.480
10.49	-.610
11.97	-.700

RANGE 7.6

STA (M)	ELEV (M)
0.00	.290
1.00	.180
1.46	.135
2.00	.060
2.43	-.015
3.15	-.060
3.60	-.145
4.40	-.160
5.34	-.215
6.14	-.225
6.60	-.275
7.60	-.305
8.57	-.420
10.00	-.545
11.98	-.710

TEST 6

RANGE 1.5

STA (M)	ELEV (M)
0.00	.275
1.00	.175
1.85	.155
2.80	.095
3.10	-.035
3.30	-.085
3.80	-.095
4.80	-.135
5.20	-.235
5.90	-.240
6.70	-.300
7.10	-.335
7.70	-.365
8.00	-.390
8.60	-.475
9.20	-.510
9.60	-.545
10.30	-.590
10.90	-.650
11.40	-.685
11.90	-.715

RANGE 2.0

STA (M)	ELEV (M)
0.00	.285
.70	.215
1.10	.180
1.50	.135
1.80	.150
2.60	.065
3.20	-.035
3.50	-.100
3.75	-.085
4.40	-.140
5.05	-.205
5.70	-.235
6.50	-.275
7.00	-.325
7.40	-.335
8.10	-.405
8.90	-.495
9.60	-.535
10.30	-.605
11.20	-.675
11.90	-.710

RANGE 3.0

STA (M)	ELEV (M)
0.00	.285
1.00	.195
1.50	.155
2.20	.110
2.90	.020
3.90	-.065
4.20	-.140
4.70	-.145
5.50	-.235
6.40	-.255
7.20	-.345
8.20	-.415
9.20	-.505
10.10	-.585
11.10	-.675

RANGE 4.0

STA (M)	ELEV (M)
0.00	.295
1.40	.145
2.30	.100
2.80	.005
3.30	-.065
4.00	-.140
4.90	-.185
5.80	-.225
6.80	-.305
7.80	-.405
8.80	-.475
9.90	-.570
10.95	-.665
11.90	-.705

RANGE 5.0

STA (M)	ELEV (M)
0.00	.285
1.40	.165
2.05	.105
2.70	-.005
3.00	-.070
3.30	-.075
3.75	-.145
4.90	-.155
5.40	-.215
6.30	-.285
7.60	-.375
8.80	-.475
9.85	-.575
10.90	-.675
11.90	-.705

RANGE 6.0

STA (M)	ELEV (M)
0.00	.290
1.10	.180
1.80	.115
2.60	-.015
3.20	-.070
3.40	-.155
3.65	-.105
4.35	-.160
5.10	-.235
6.10	-.260
7.10	-.360
7.80	-.375
8.90	-.485
9.90	-.575
10.90	-.670
11.90	-.705

RANGE 7.0

STA (M)	ELEV (M)
0.00	.280
1.30	.160
1.60	.160
2.60	-.010
3.10	-.075
3.40	-.165
3.60	-.085
4.40	-.155
5.10	-.240
5.85	-.235
6.90	-.325
8.30	-.445
9.50	-.535
10.70	-.645
11.90	-.705

RANGE 7.6

STA (M)	ELEV (M)
0.00	.275
1.30	.145
2.15	.055
2.85	-.055
3.10	-.115
3.50	-.070
4.60	-.155
5.40	-.235
6.50	-.290
7.80	-.365
8.85	-.470
9.80	-.550
10.80	-.635
11.90	-.705

TEST 7

RANGE 1.5

STA (M)	ELEV (M)
0.00	.285
1.53	.100
2.02	.120
2.38	.075
2.82	-.020
3.50	-.060
3.87	-.100
4.18	-.095
4.64	-.145
4.91	-.180
5.15	-.165
5.85	-.235
6.43	-.245
6.82	-.300
8.06	-.395
9.00	-.480
10.00	-.575
11.00	-.645
12.25	-.715

RANGE 2.0

STA (M)	ELEV (M)
0.00	.285
1.55	.110
2.05	.120
2.91	-.025
3.18	-.045
3.58	-.055
3.95	-.125
4.27	-.085
4.64	-.155
4.97	-.145
5.85	-.245
6.42	-.255
7.43	-.340
8.48	-.430
9.00	-.485
10.00	-.565
11.00	-.650
12.25	-.715

RANGE 3.0

STA (M)	ELEV (M)
0.00	.295
1.83	.085
2.30	.045
2.79	-.030
3.38	-.070
4.11	-.130
4.66	-.105
5.78	-.200
6.48	-.230
7.24	-.315
7.80	-.340
8.77	-.465
9.00	-.495
10.00	-.580
11.00	-.660
12.25	-.715

RANGE 4.0

STA (M)	ELEV (M)
0.00	.290
1.30	.150
1.34	.085
2.13	-.035
2.39	-.045
2.63	-.060
2.89	-.085
3.38	-.075
3.95	-.155
4.40	-.160
4.48	-.150
5.50	-.200
6.18	-.195
6.67	-.245
7.61	-.305
8.26	-.360
8.83	-.460
9.74	-.565
10.53	-.635
11.00	-.655
12.25	-.715

RANGE 5.0

STA (M)	ELEV (M)
0.00	.295
1.23	.180
1.23	.095
1.82	-.015
2.41	-.095
3.17	-.080
3.28	-.100
3.92	-.155
4.61	-.170
5.18	-.220
5.86	-.205
6.61	-.280
7.28	-.270
7.90	-.320
8.68	-.435
9.35	-.535
10.27	-.615
11.00	-.670
12.25	-.715

RANGE 6.0

STA (M)	ELEV (M)
0.00	.290
.95	.185
.95	.100
1.23	.090
1.72	-.025
2.29	-.100
2.46	-.135
3.04	-.115
3.35	-.135
4.00	-.205
4.76	-.165
5.30	-.245
6.10	-.220
6.70	-.305
7.33	-.305
8.21	-.425
8.98	-.495
9.53	-.555
10.00	-.590
11.00	-.715
12.25	-.715

RANGE 7.0

STA (M)	ELEV (M)
0.00	.280
.59	.230
.59	.125
1.59	-.025
2.19	-.080
2.52	-.080
3.08	-.165
3.83	-.220
4.75	-.205
5.23	-.245
5.89	-.225
6.76	-.295
7.38	-.300
8.39	-.435
9.16	-.500
10.00	-.580
11.00	-.665
11.82	-.705
12.25	-.715

RANGE 7.6

STA (M)	ELEV (M)
0.00	.275
.08	.255
.08	.130
1.35	-.015
1.75	-.080
2.65	-.175
3.07	-.085
3.49	-.125
3.94	-.190
4.69	-.200
5.17	-.250
5.61	-.225
6.32	-.225
6.88	-.290
7.67	-.325
8.36	-.420
9.00	-.485
10.00	-.570
11.00	-.655
11.90	-.700
12.25	-.710

TEST 8

RANGE 1.5

STA (M)	ELEV (M)
0.00	.245
.46	.215
.52	.115
.83	.040
1.18	-.025
1.52	-.075
1.87	-.065
2.15	-.120
2.51	-.145
2.67	-.170
2.72	-.175
3.40	-.175
4.87	-.215
6.49	-.245
7.46	-.325
8.48	-.425
9.44	-.510
10.19	-.580
10.99	-.625
11.93	-.710

RANGE 2.0

STA (M)	ELEV (M)
0.00	.280
.32	.265
.40	.115
.79	.030
1.11	-.025
1.60	-.065
2.29	-.130
2.93	-.155
3.46	-.170
3.95	-.185
4.70	-.195
5.11	-.190
5.68	-.205
6.43	-.245
7.25	-.305
7.78	-.370
8.45	-.415
9.38	-.510
10.16	-.570
10.98	-.645
11.93	-.710

RANGE 3.0

STA (M)	ELEV (M)
0.00	.285
.42	.260
.45	.115
1.38	-.015
1.86	-.060
2.31	-.095
3.31	-.175
3.76	-.185
4.34	-.190
4.81	-.175
5.58	-.230
6.65	-.240
7.38	-.315
8.10	-.375
8.76	-.445
9.40	-.510
10.14	-.565
10.95	-.645
11.93	-.700

RANGE 4.0

STA (M)	ELEV (M)
0.00	.295
.79	.215
.95	.070
1.76	-.015
2.63	-.120
3.63	-.175
4.32	-.150
5.13	-.170
5.70	-.215
6.74	-.225
7.54	-.285
8.32	-.365
9.41	-.520
9.92	-.575
10.68	-.640
11.40	-.695
11.93	-.705

RANGE 5.0

STA (M)	ELEV (M)
0.00	.300
.42	.210
.86	.130
1.63	-.010
2.21	-.125
3.16	-.165
3.68	-.180
4.68	-.175
5.65	-.205
6.50	-.250
7.55	-.285
8.38	-.355
9.31	-.535
10.09	-.605
10.99	-.660
11.93	-.705

RANGE 6.0

STA (M)	ELEV (M)
0.00	.300
.76	.235
.83	.115
1.75	-.015
2.05	-.065
2.64	-.115
3.22	-.145
4.03	-.235
5.15	-.245
5.55	-.212
6.92	-.241
8.05	-.395
9.48	-.551
10.20	-.615
11.93	-.705

RANGE 7.0

STA (M)	ELEV (M)
0.00	.295
.65	.230
.69	.145
1.78	-.005
3.14	-.140
4.32	-.215
5.04	-.245
5.76	-.205
6.43	-.265
6.80	-.270
7.91	-.345
8.81	-.455
9.58	-.540
10.28	-.610
11.06	-.655
11.93	-.695

RANGE 7.6

STA (M)	ELEV (M)
0.00	.285
.58	.220
.63	.155
1.72	-.015
2.78	-.145
3.48	-.175
4.26	-.185
5.10	-.225
6.27	-.235
7.32	-.300
8.20	-.405
9.79	-.555
10.65	-.625
11.93	-.695

TEST 9

RANGE 1.5

STA (M)	ELEV (M)
0.00	.270
1.13	.155
1.38	.170
1.68	.080
1.82	.075
2.63	-.005
3.09	-.040
3.38	-.065
3.85	-.135
4.23	-.140
4.77	-.195
5.27	-.175
5.84	-.205
6.23	-.190
6.81	-.245
7.30	-.250
7.76	-.320
8.45	-.385
9.36	-.500
10.20	-.595
11.90	-.715

RANGE 2.0

STA (M)	ELEV (M)
0.00	.285
1.18	.125
1.67	.130
2.00	.100
2.73	-.005
3.32	-.060
3.85	-.155
4.44	-.165
5.30	-.205
5.56	-.190
5.90	-.210
6.46	-.205
6.92	-.240
7.37	-.260
8.13	-.360
8.90	-.420
10.10	-.535
11.93	-.710

RANGE 3.0

STA (M)	ELEV (M)
0.00	.295
1.36	.115
1.73	.075
2.02	.075
2.69	-.020
3.03	-.080
3.36	-.070
3.91	-.145
4.45	-.170
5.15	-.220
6.46	-.200
6.97	-.240
7.53	-.245
8.22	-.320
8.87	-.405
9.92	-.550
11.92	-.710

RANGE 4.0

STA (M)	ELEV (M)
0.00	.300
1.58	.090
2.02	.065
2.33	.010
3.07	-.060
3.42	-.050
3.97	-.085
4.68	-.150
5.57	-.225
6.15	-.220
6.86	-.210
7.78	-.245
8.43	-.295
9.59	-.530
10.83	-.620
11.82	-.710

RANGE 5.0

STA (M)	ELEV (M)
0.00	.345
1.40	.135
1.40	.290
1.65	.080
1.85	.095
2.49	.010
3.35	-.140
4.20	-.165
4.85	-.215
5.30	-.240
6.17	-.190
8.08	-.220
8.10	-.250
9.30	-.450
10.48	-.625
11.85	-.710

RANGE 6.0

STA (M)	ELEV (M)
0.00	.300
1.61	.090
2.03	.085
2.57	.015
3.17	-.065
3.38	-.070
4.68	-.170
5.18	-.175
5.85	-.165
6.55	-.220
7.16	-.230
8.09	-.290
9.42	-.535
10.61	-.640
11.80	-.705

RANGE 7.0

STA (M)	ELEV (M)
0.00	.295
1.28	.140
1.81	.070
2.31	-.005
2.66	-.070
3.12	-.065
4.00	-.215
4.66	-.200
5.17	-.165
6.15	-.180
6.97	-.230
7.64	-.310
8.36	-.410
9.31	-.490
11.72	-.705

RANGE 7.6

STA (M)	ELEV (M)
0.00	.290
1.24	.140
2.00	.020
2.89	-.125
3.23	-.085
3.85	-.170
4.62	-.170
5.00	-.195
5.[illegible]	-.190
6.59	-.220
7.30	-.280
8.05	-.370
9.24	-.480
11.73	-.705

TEST 10

RANGE 1.5

STA (M)	ELEV (M)
0.00	.280
1.04	.155
1.04	.135
2.07	-.010
2.64	-.055
3.48	-.095
3.91	-.165
4.15	-.195
4.42	-.215
5.05	-.200
5.60	-.225
6.40	-.290
6.95	-.315
7.43	-.350
8.35	-.425
8.90	-.450
9.57	-.465
10.40	-.535
11.15	-.605
11.92	-.685

RANGE 2.0

STA (M)	ELEV (M)
0.00	.285
.98	.175
1.07	.135
1.85	.015
2.05	-.015
2.85	-.095
3.65	-.105
4.13	-.155
4.45	-.210
5.02	-.150
5.79	-.250
6.52	-.300
6.97	-.305
7.60	-.365
8.30	-.430
9.28	-.465
10.00	-.495
10.69	-.565
11.95	-.680

RANGE 3.0

STA (M)	ELEV (M)
0.00	.285
1.25	.130
1.37	.055
2.15	.005
3.00	-.070
3.52	-.110
3.92	-.125
4.40	-.200
4.86	-.135
5.65	-.225
6.52	-.275
7.68	-.355
8.58	-.440
9.82	-.495
10.92	-.610
11.92	-.655

RANGE 4.0

STA (M)	ELEV (M)
0.00	.300
1.59	.115
1.65	.105
2.57	.010
3.79	-.075
4.32	-.145
4.70	-.110
5.48	-.225
6.38	-.255
7.22	-.335
8.24	-.405
9.47	-.500
10.75	-.630
11.93	-.655

RANGE 5.0

STA (M)	ELEV (M)
0.00	.295
1.16	.170
1.27	.145
1.85	.085
2.53	.010
3.47	-.060
4.22	-.125
4.75	-.100
5.58	-.220
6.49	-.250
7.45	-.325
8.50	-.430
9.46	-.540
10.47	-.625
11.38	-.690
11.93	-.665

RANGE 6.0

STA (M)	ELEV (M)
0.00	.300
1.66	.115
2.09	-.005
3.33	-.070
3.70	-.090
4.63	-.165
5.63	-.160
6.52	-.255
7.79	-.350
8.60	-.445
9.58	-.550
10.67	-.650
11.93	-.675

RANGE 7.0

STA (M)	ELEV (M)
0.00	.295
1.58	.115
2.08	.070
2.85	.005
3.54	-.090
4.45	-.175
5.23	-.165
6.47	-.245
7.62	-.330
8.73	-.455
9.56	-.545
10.61	-.640
11.93	-.690

RANGE 7.6

STA (M)	ELEV (M)
0.00	.290
1.68	.110
2.09	.040
2.35	.005
3.73	-.125
4.46	-.175
5.03	-.195
5.61	-.265
6.27	-.235
6.87	-.280
7.88	-.360
8.64	-.435
9.60	-.535
10.38	-.595
11.92	-.695

TEST 11

RANGE 1.5

STA (M)	ELEV (M)
0.00	.280
1.50	.110
2.50	-.080
3.10	-.080
3.22	-.070
3.45	-.120
3.79	-.090
4.25	-.170
5.17	-.190
6.62	-.300
7.43	-.350
8.63	-.460
9.51	-.580
10.60	-.610
11.94	-.710

RANGE 2.0

STA (M)	ELEV (M)
0.00	.290
1.34	.120
1.60	.090
1.70	.070
2.34	-.020
3.02	-.040
4.13	-.150
4.84	-.180
5.28	-.180
6.10	-.260
6.91	-.300
7.39	-.350
8.46	-.440
9.47	-.520
10.55	-.610
11.48	-.690
11.95	-.710

RANGE 3.0

STA (M)	ELEV (M)
0.00	.300
1.14	.150
1.27	.180
2.33	-.010
2.59	-.040
2.70	-.080
3.08	-.090
3.29	-.130
3.60	-.070
4.08	-.140
4.62	-.200
5.28	-.210
6.12	-.270
7.14	-.330
7.99	-.420
8.93	-.490
9.97	-.580
11.11	-.670
11.90	-.720

RANGE 4.0

STA (M)	ELEV (M)
0.00	.300
.93	.190
1.03	.110
1.82	.010
2.40	-.020
3.05	-.110
3.58	-.100
4.19	-.170
5.14	-.220
5.05	-.290
6.82	-.320
7.79	-.390
8.48	-.480
9.46	-.570
10.87	-.660
11.57	-.710
11.93	-.710

RANGE 5.0

STA (M)	ELEV (M)
0.00	.310
.93	.200
1.01	.115
1.88	.015
2.65	-.075
3.01	-.105
3.52	-.095
3.85	-.190
4.79	-.180
5.44	-.260
6.63	-.290
7.48	-.385
8.39	-.460
9.42	-.530
10.16	-.580
11.23	-.685
11.94	-.710

RANGE 6.0

STA (M)	ELEV (M)
0.00	.310
.96	.200
1.03	.120
1.85	.015
2.13	-.035
3.20	-.070
3.71	-.135
4.43	-.170
4.98	-.205
5.95	-.270
6.92	-.325
7.51	-.365
8.25	-.450
9.48	-.550
10.29	-.610
11.20	-.675
11.91	-.705

RANGE 7.0

STA (M)	ELEV (M)
0.00	.310
.88	.200
.96	.110
1.85	.055
2.38	-.065
2.87	-.110
3.16	-.165
3.42	-.075
3.74	-.120
4.38	-.170
4.98	-.200
5.83	-.230
6.75	-.290
7.64	-.360
8.72	-.460
9.79	-.550
10.60	-.630
11.27	-.675
11.98	-.700

RANGE 7.6

STA (M)	ELEV (M)
0.00	.305
.75	.205
1.02	.185
1.15	.135
1.80	.030
2.17	-.010
2.79	-.030
3.14	-.040
3.65	-.120
4.42	-.175
5.05	-.195
5.82	-.220
6.60	-.245
7.56	-.335
8.54	-.425
9.39	-.500
10.34	-.585
11.03	-.650
11.94	-.700

TEST 12

RANGE 1.5

STA (M)	ELEV (M)
0.00	.280
.70	.215
1.65	.125
2.60	-.041
3.12	-.075
3.52	-.180
4.05	-.145
4.80	-.250
5.66	-.245
6.66	-.330
7.23	-.340
7.80	-.395
8.63	-.470
9.35	-.510
9.85	-.505
10.53	-.610
10.90	-.650
11.24	-.670
11.71	-.705
11.93	-.710

RANGE 2.0

STA (M)	ELEV (M)
0.00	.290
.70	.205
1.31	.135
1.67	.175
2.55	0.000
3.10	-.085
3.46	-.075
3.78	-.160
4.18	-.150
4.90	-.250
5.86	-.240
6.61	-.335
7.23	-.350
7.98	-.390
8.78	-.500
9.35	-.505
10.00	-.580
10.80	-.640
11.39	-.690
11.87	-.710

RANGE 3.0

STA (M)	ELEV (M)
0.00	.300
1.18	.120
1.74	.150
2.50	.060
3.30	-.060
3.52	-.070
3.86	-.130
4.02	-.140
5.00	-.220
5.92	-.225
6.84	-.330
7.15	-.345
7.71	-.400
8.45	-.430
9.12	-.510
10.00	-.580
10.74	-.645
11.62	-.710

RANGE 4.0

STA (M)	ELEV (M)
0.00	.310
1.15	.135
1.37	.095
2.06	.095
2.25	.080
2.66	.065
3.42	-.065
3.68	-.070
4.06	-.130
4.70	-.140
5.61	-.240
6.19	-.220
6.96	-.330
7.42	-.380
8.24	-.410
9.30	-.500
10.27	-.610
10.84	-.650
11.40	-.695

RANGE 5.0

STA (M)	ELEV (M)
0.00	.310
1.57	.100
2.01	.095
2.70	.010
3.10	-.036
3.38	-.060
3.92	-.155
4.71	-.140
5.30	-.200
5.82	-.270
6.84	-.310
7.94	-.430
8.78	-.460
9.40	-.540
10.24	-.600
11.05	-.670
11.55	-.705

RANGE 6.0

STA (M)	ELEV (M)
0.00	.310
1.25	.135
1.60	.160
2.40	.005
2.80	-.055
3.02	-.070
3.61	-.145
4.21	-.170
5.00	-.240
5.55	-.230
6.43	-.300
7.20	-.375
7.93	-.390
8.84	-.491
9.57	-.565
10.15	-.600
10.86	-.670
11.40	-.690
11.93	-.705

RANGE 7.0

STA (M)	ELEV (M)
0.00	.285
.97	.180
1.67	.160
2.48	0.000
3.05	-.060
3.51	-.195
4.09	-.145
4.62	-.210
5.00	-.230
5.35	-.270
5.89	-.230
6.70	-.285
7.38	-.350
8.07	-.355
8.90	-.485
9.52	-.520
10.18	-.590
10.65	-.620
11.20	-.690
11.83	-.705

RANGE 7.6

STA (M)	ELEV (M)
0.00	.290
.96	.190
1.20	.175
1.75	.100
2.35	.005
2.78	-.060
3.17	-.096
3.38	-.100
3.77	-.165
4.25	-.160
4.87	-.215
5.68	-.260
6.12	-.280
6.90	-.285
7.97	-.350
8.23	-.386
8.82	-.460
9.37	-.490
9.82	-.540
10.40	-.605
10.82	-.620
11.33	-.695
11.96	-.705

TEST 13

RANGE 1.5

STA (M)	ELEV (M)
0.00	.285
1.00	.170
1.35	.150
1.43	.150
1.49	.120
1.80	.090
2.40	.005
2.79	-.050
3.01	-.131
3.58	-.210
4.16	-.215
4.71	-.205
5.52	-.230
6.31	-.280
6.92	-.330
7.49	-.370
8.28	-.430
8.79	-.475
9.48	-.515
10.24	-.590
11.09	-.655
11.93	-.710

RANGE 2.0

STA (M)	ELEV (M)
0.00	.295
.60	.215
.82	.175
1.10	.165
1.25	.165
1.32	.145
1.80	.055
2.15	.005
2.49	-.050
2.77	-.130
3.13	-.200
3.91	-.215
4.45	-.215
4.82	-.200
5.65	-.240
6.49	-.290
7.01	-.330
7.42	-.360
8.30	-.430
8.82	-.480
9.49	-.525
10.17	-.580
11.18	-.660
11.93	-.710

RANGE 3.0

STA (M)	ELEV (M)
0.00	.310
.88	.180
1.59	.100
2.09	.020
2.53	-.075
2.92	-.155
3.62	-.215
4.41	-.220
4.93	-.220
5.62	-.240
6.43	-.295
6.96	-.330
7.48	-.350
8.19	-.430
9.22	-.520
10.19	-.590
11.15	-.685
11.88	-.710

RANGE 4.0

STA (M)	ELEV (M)
0.00	.310
.56	.245
.95	.175
1.02	.140
1.84	.055
2.34	-.010
2.80	-.095
3.40	-.195
4.33	-.180
4.99	-.195
5.63	-.265
5.97	-.260
6.45	-.300
7.00	-.335
7.68	-.365
8.44	-.455
9.39	-.520
10.34	-.600
11.25	-.680
11.95	-.710

RANGE 5.0

STA (M)	ELEV (M)
0.00	.315
.68	.215
.75	.185
1.37	.160
1.88	.090
2.46	-.015
3.05	-.105
3.61	-.220
4.29	-.160
4.99	-.160
5.53	-.255
6.22	-.290
6.95	-.325
7.57	-.360
8.41	-.460
9.27	-.515
9.89	-.575
10.78	-.645
11.44	-.695
11.95	-.710

RANGE 6.0

STA (M)	ELEV (M)
0.00	.315
.84	.200
1.24	.210
1.87	.130
2.48	.010
2.75	-.050
2.96	-.085
3.09	-.150
3.68	-.255
4.62	-.180
5.13	-.210
5.95	-.290
6.74	-.355
7.46	-.365
8.77	-.490
9.58	-.555
10.26	-.610
11.17	-.670
11.94	-.705

RANGE 7.0

STA (M)	ELEV (M)
0.00	.310
.82	.210
1.50	.130
2.26	.065
2.92	-.065
3.53	-.140
4.42	-.245
5.04	-.215
5.99	-.275
6.88	-.360
7.63	-.345
8.87	-.470
9.58	-.541
10.35	-.615
11.38	-.685
11.94	-.700

RANGE 7.6

STA (M)	ELEV (M)
0.00	.310
.99	.185
1.83	.085
2.53	-.005
3.39	-.090
4.44	-.220
5.31	-.220
6.28	-.270
6.91	-.310
7.75	-.340
8.77	-.430
9.53	-.520
10.42	-.600
11.41	-.690
11.97	-.705

TEST 14

RANGE 1.5

STA (M)	ELEV (M)
0.00	.285
.40	.240
.59	.225
.70	.090
1.26	.030
1.53	-.020
2.23	-.080
2.91	-.200
3.58	-.290
4.31	-.255
4.94	-.285
5.63	-.300
6.39	-.300
7.47	-.365
8.56	-.490
9.50	-.550
10.44	-.640
11.27	-.685
11.98	-.710

RANGE 2.0

STA (M)	ELEV (M)
0.00	.290
.29	.255
.41	.115
.97	.015
1.16	-.025
1.63	-.090
2.14	-.135
2.92	-.225
3.59	-.200
4.24	-.240
4.92	-.255
5.65	-.270
6.58	-.290
7.31	-.330
8.12	-.395
8.89	-.485
9.56	-.540
10.51	-.630
11.29	-.685
11.93	-.710

RANGE 3.0

STA (M)	ELEV (M)
0.00	.300
0.00	.040
.82	.035
1.35	-.075
1.79	-.110
2.26	-.200
3.20	-.220
3.93	-.240
4.95	-.245
5.80	-.275
6.74	-.330
7.63	-.385
8.82	-.460
9.85	-.555
10.91	-.670
11.37	-.710
11.93	-.715

RANGE 4.0

STA (M)	ELEV (M)
0.00	.305
0.00	.110
.66	.040
1.37	-.080
1.85	-.115
2.16	-.180
3.00	-.260
3.93	-.310
4.87	-.310
5.72	-.325
6.73	-.315
7.69	-.425
8.75	-.515
9.78	-.515
10.81	-.680
11.45	-.710
11.92	-.710

RANGE 5.0

STA (M)	ELEV (M)
0.00	.310
.23	.290
.28	.130
1.15	-.010
1.78	-.080
2.21	-.115
2.36	-.165
3.23	-.265
4.02	-.285
4.72	-.295
5.71	-.390
6.67	-.310
7.35	-.360
8.19	-.435
9.32	-.540
9.95	-.530
10.71	-.655
11.34	-.715
11.95	-.715

RANGE 6.0

STA (M)	ELEV (M)
0.00	.305
.13	.300
.13	.170
1.22	.020
1.82	-.040
2.52	-.110
2.81	-.155
3.50	-.240
4.23	-.260
4.94	-.285
5.76	-.360
6.30	-.390
7.00	-.320
7.72	-.390
8.55	-.445
9.40	-.545
10.24	-.550
11.15	-.660
11.93	-.705

RANGE 7.0

STA (M)	ELEV (M)
0.00	.305
0.00	.235
.92	.194
1.72	.040
2.22	-.040
2.95	-.135
3.65	-.140
4.43	-.210
5.16	-.285
6.34	-.375
6.98	-.355
8.06	-.425
8.92	-.480
9.78	-.560
11.01	-.585
11.95	-.670

RANGE 7.6

STA (M)	ELEV (M)
0.00	.305
.33	.255
.77	.230
1.52	.120
2.06	.010
3.00	-.090
3.34	-.165
4.01	-.130
4.94	-.210
6.04	-.310
6.97	-.365
7.92	-.420
8.74	-.485
9.53	-.540
10.47	-.590
11.45	-.631
11.94	-.665

TEST 15

RANGE 1.5

STA (M)	ELEV (M)
0.00	.280
1.10	.140
1.15	.100
1.35	.095
2.05	-.030
2.60	-.095
3.35	-.205
4.20	-.235
5.50	-.290
6.75	-.310
7.75	-.365
8.75	-.445
10.07	-.540
11.15	-.685
11.93	-.705

RANGE 2.0

STA (M)	ELEV (M)
0.00	.285
.85	.175
.85	.135
1.83	-.010
2.46	-.090
3.35	-.230
3.92	-.231
4.60	-.285
6.05	-.300
6.95	-.326
7.95	-.400
8.80	-.455
10.05	-.545
11.10	-.630
11.93	-.695

RANGE 3.0

STA (M)	ELEV (M)
0.00	.290
.63	.205
.63	.140
1.83	0.000
2.24	-.061
2.51	-.070
2.95	-.145
3.48	-.145
4.28	-.245
5.17	-.305
6.26	-.305
6.90	-.310
7.75	-.370
8.70	-.445
9.88	-.535
10.97	-.655
11.93	-.705

RANGE 4.0

STA (M)	ELEV (M)
0.00	.285
.85	.180
.85	.125
1.13	.120
1.77	.015
3.00	-.085
3.30	-.155
3.55	-.305
3.78	-.110
3.90	-.140
4.85	-.220
6.00	-.280
6.91	-.310
7.82	-.380
8.75	-.420
10.03	-.575
11.08	-.690
11.93	-.705

RANGE 5.0

STA (M)	ELEV (M)
0.00	.305
.80	.200
.80	.115
1.35	.110
1.42	.095
2.20	.015
3.35	-.075
3.63	-.120
3.82	-.080
4.04	-.090
4.15	-.130
4.78	-.195
5.80	-.270
6.88	-.255
7.78	-.315
8.75	-.420
9.90	-.570
11.03	-.680
11.03	-.695

RANGE 6.0

STA (M)	ELEV (M)
0.00	.295
.96	.170
1.00	.125
1.60	.085
2.61	0.000
2.75	-.015
3.54	-.070
3.73	-.120
3.90	-.090
4.10	-.095
4.90	-.155
6.51	-.230
7.66	-.325
8.75	-.420
10.10	-.600
11.20	-.691
11.93	-.705

RANGE 7.0

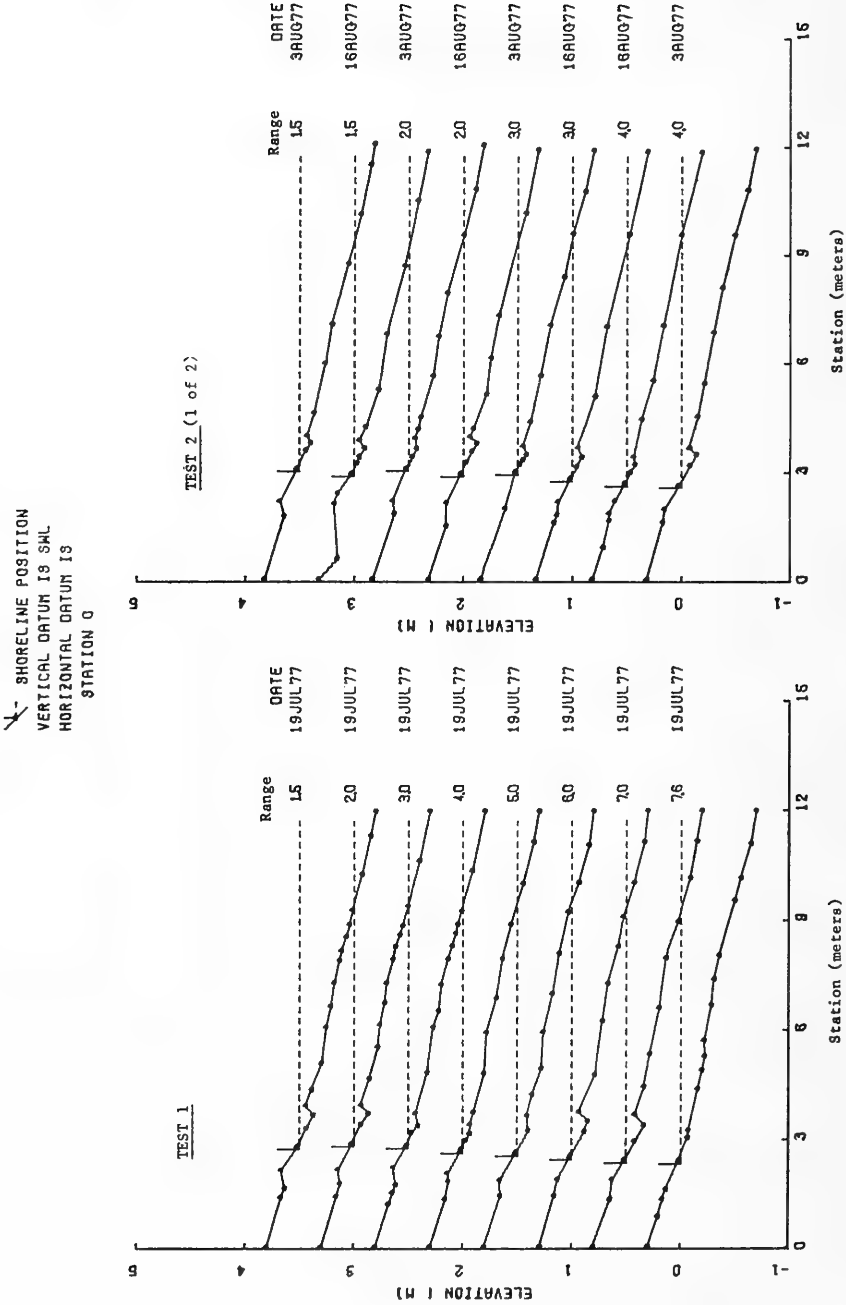
STA (M)	ELEV (M)
0.00	.295
.95	.190
1.36	.125
1.84	.105
2.60	.010
2.90	-.030
3.34	-.080
3.62	-.090
3.83	-.125
4.04	-.105
4.25	-.150
5.05	-.180
6.45	-.240
7.47	-.330
8.72	-.415
10.10	-.591
11.20	-.690
11.93	-.705

RANGE 7.6

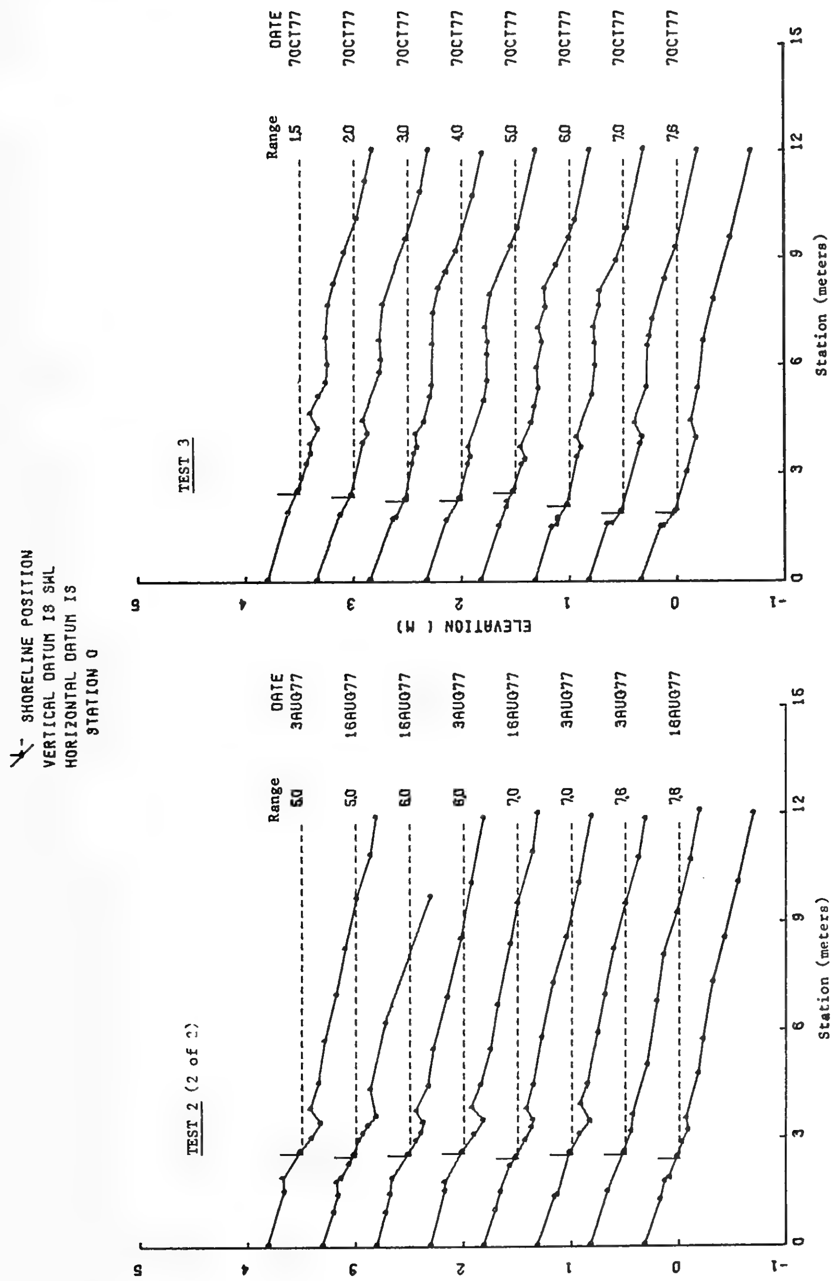
STA (M)	ELEV (M)
0.00	.300
1.00	.180
1.23	.140
1.65	.125
2.34	.040
2.55	-.005
3.20	-.070
3.75	-.125
3.95	-.170
4.35	-.120
4.70	-.180
6.91	-.285
8.00	-.380
8.76	-.450
9.90	-.570
11.07	-.655
11.93	-.700

APPENDIX C

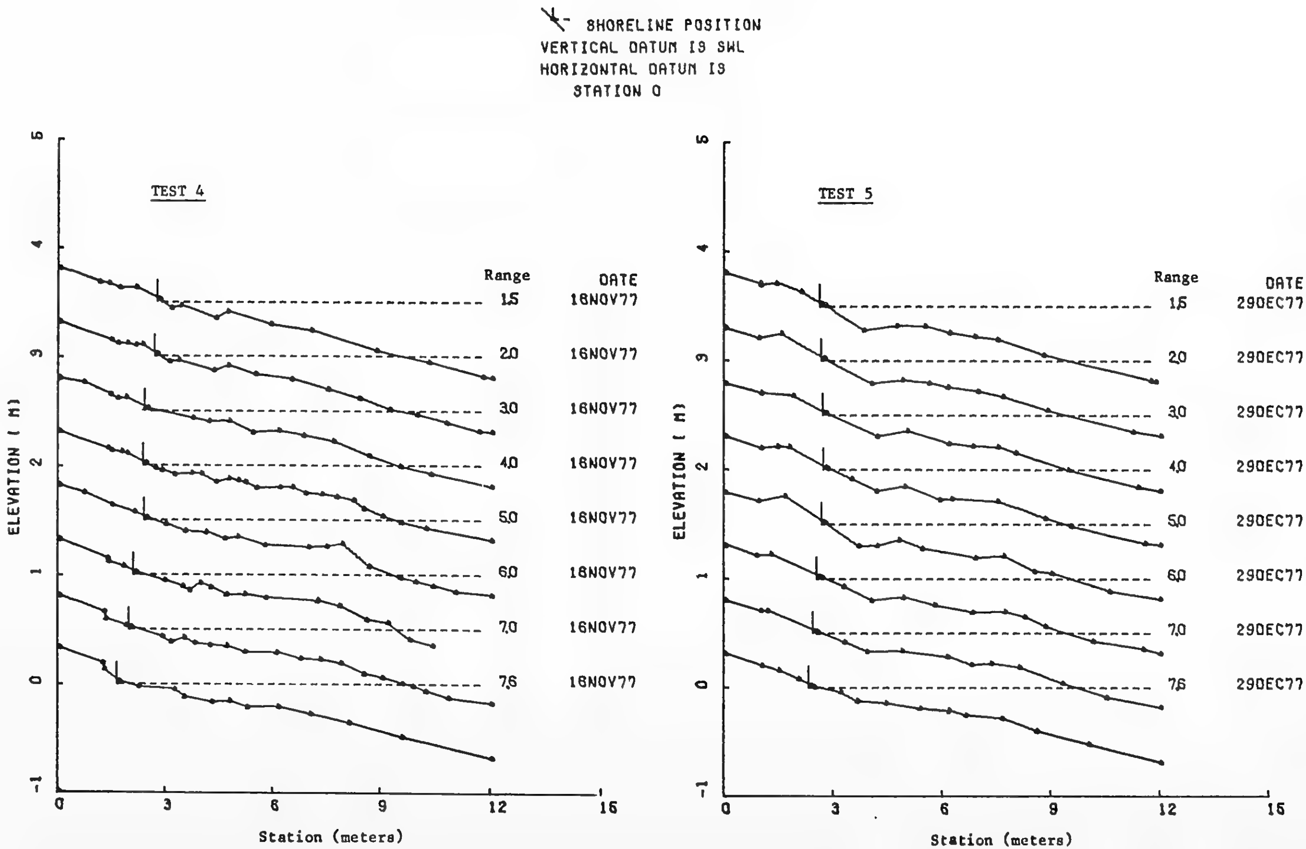
PLOTTED BEACH PROFILES

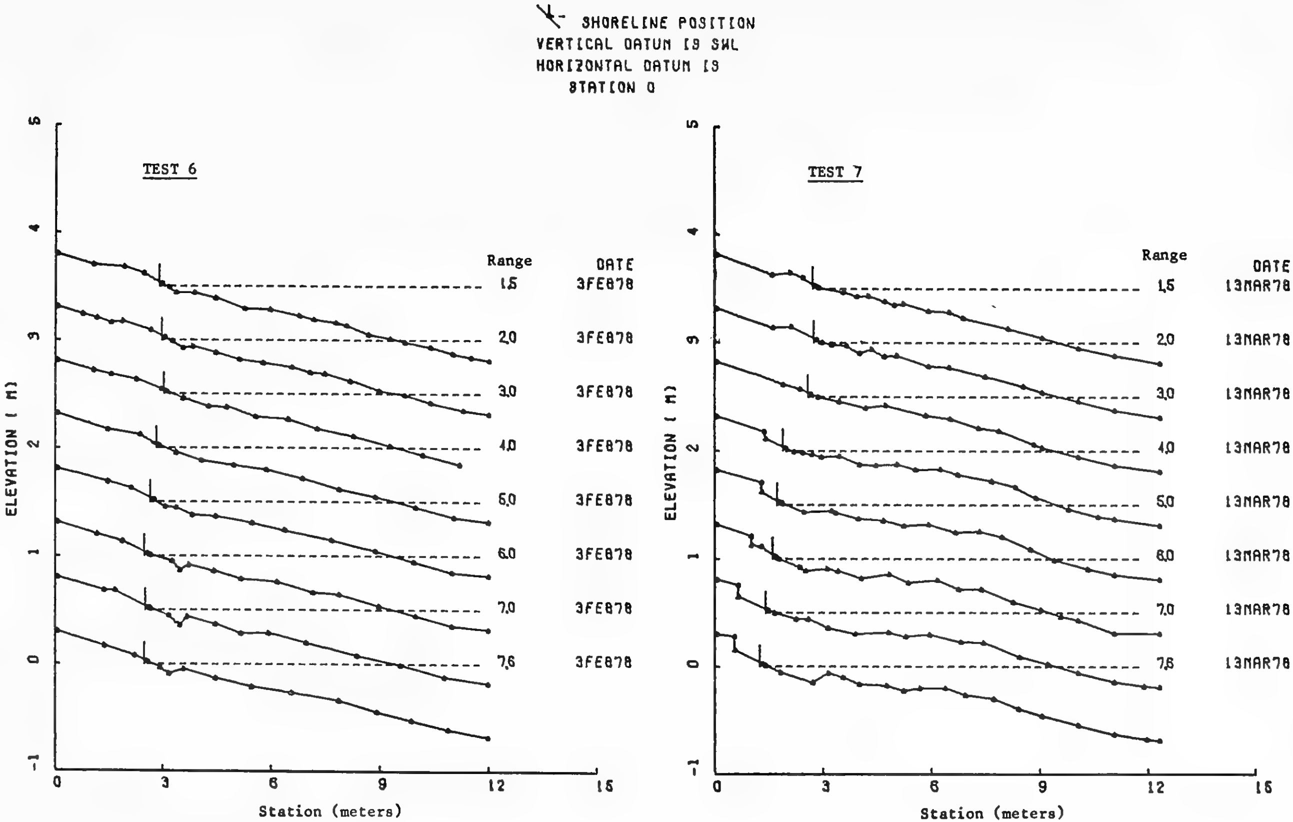


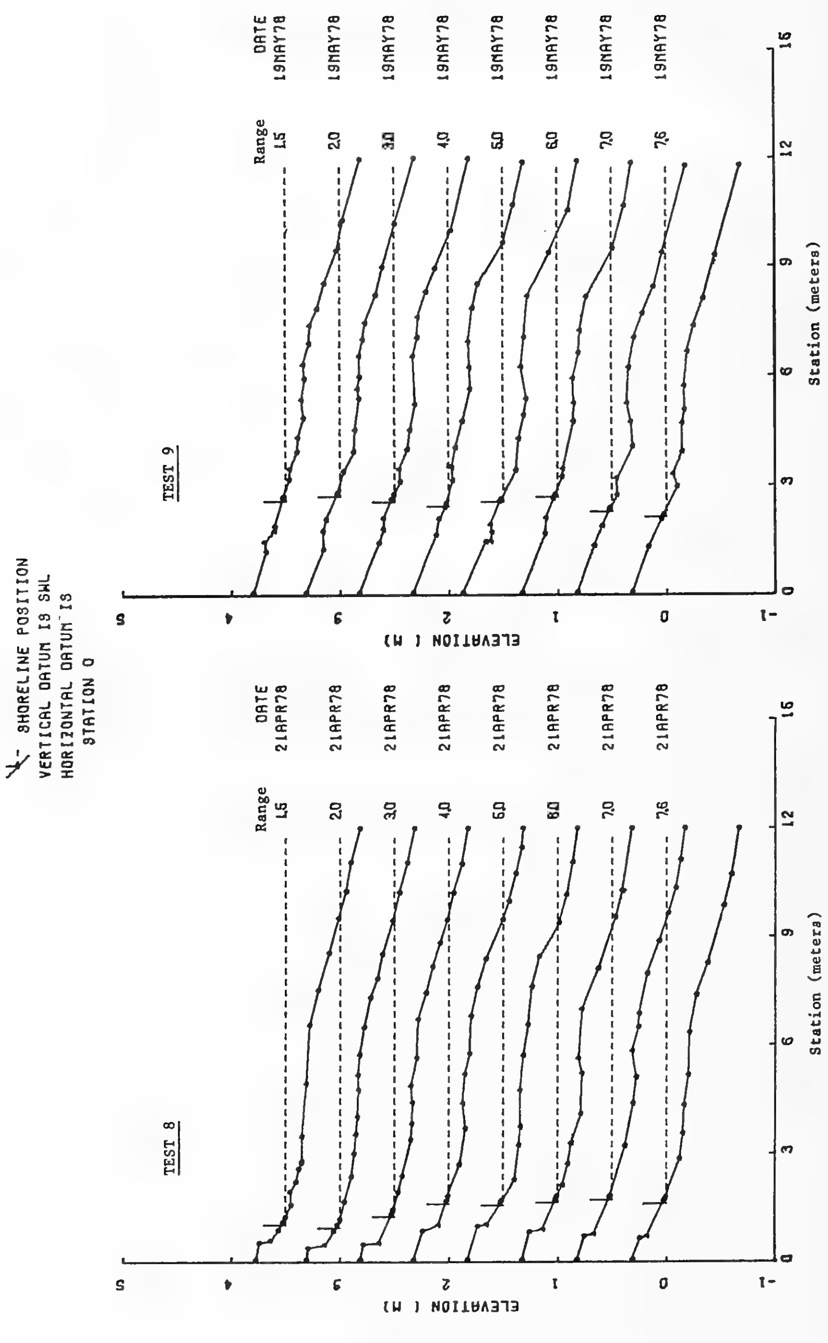
SHORELINE POSITION
VERTICAL DATUM IS SWL
HORIZONTAL DATUM IS STATION 0
TEST 1
Range
1.5
2.0
3.0
4.0
5.0
6.0
7.0
7.6
DATE
19JUL77
19JUL77
19JUL77
19JUL77
19JUL77
19JUL77
19JUL77
19JUL77
ELEVATION (M)
Station (meters)
TEST 2 (1 of 2)
Range
1.5
1.5
2.0
2.0
3.0
3.0
4.0
4.0
DATE
3AUG77
16AUG77
3AUG77
16AUG77
3AUG77
16AUG77
16AUG77
3AUG77
ELEVATION (M)
Station (meters)

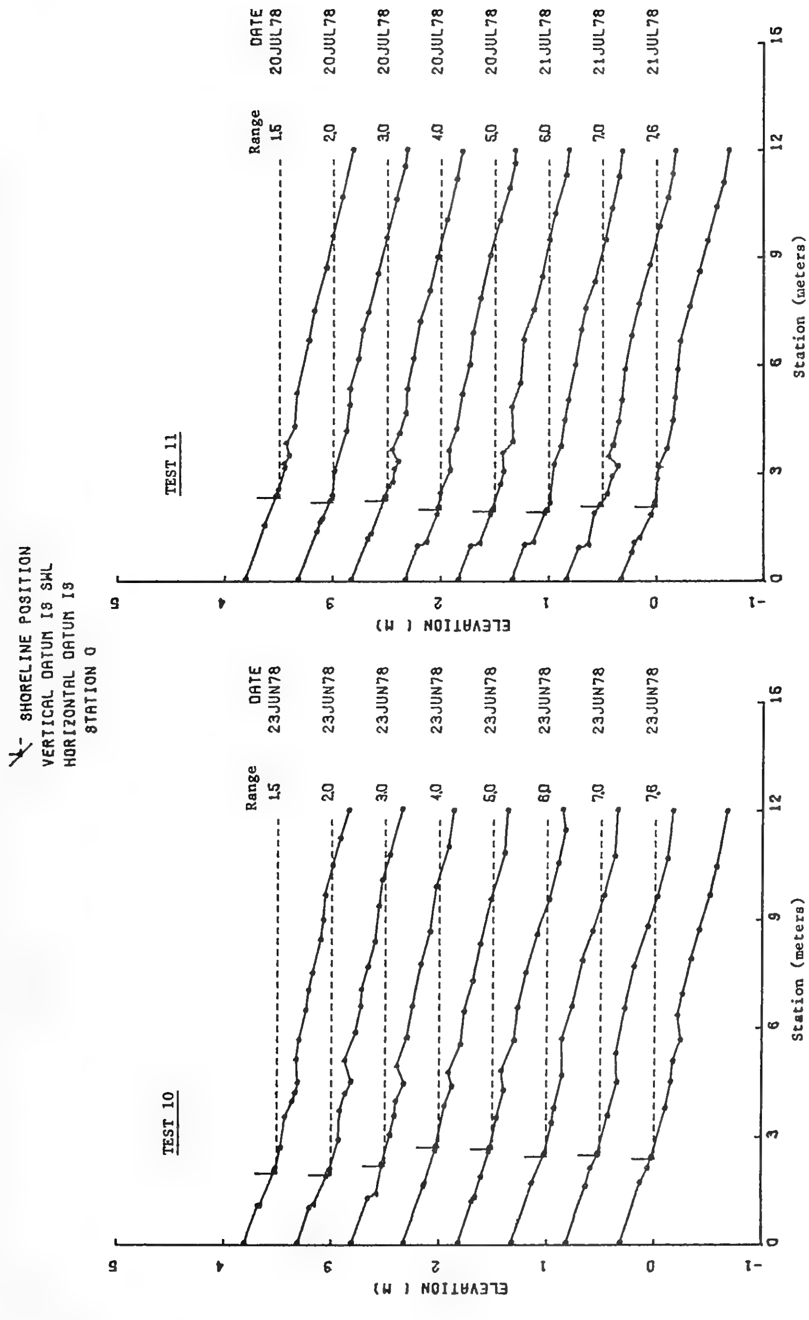


SHORELINE POSITION
VERTICAL DATUM IS SWL
HORIZONTAL DATUM IS
STATION 0
TEST 3
Range
1.5
2.0
3.0
4.0
5.0
6.0
7.0
7.6
DATE
7OCT77
7OCT77
7OCT77
7OCT77
7OCT77
7OCT77
7OCT77
7OCT77
ELEVATION (M)
5
4
3
2
1
0
-1
0
3
6
9
12
15
Station (meters)
TEST 2 (2 of 2)
Range
5.0
5.0
6.0
6.0
7.0
7.0
7.6
7.6
DATE
3AUG77
16AUG77
16AUG77
3AUG77
18AUG77
3AUG77
3AUG77
18AUG77
ELEVATION (M)
5
4
3
2
1
0
-1
0
3
6
9
12
15
Station (meters)

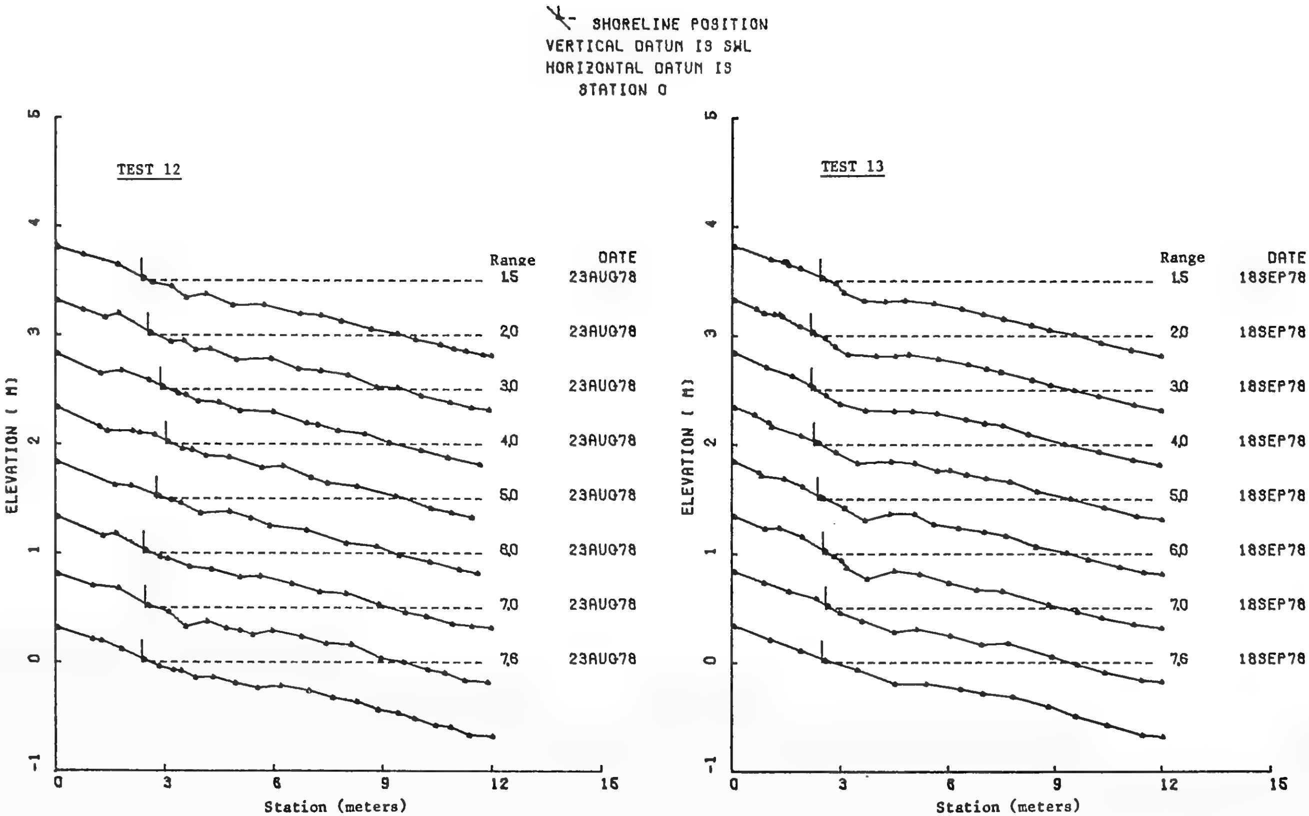

SHORELINE POSITION
VERTICAL DATUM IS SWL
HORIZONTAL DATUM IS
STATION 0
TEST 4
Range
DATE
1.5 16NOV77
2.0 16NOV77
3.0 16NOV77
4.0 16NOV77
5.0 16NOV77
6.0 16NOV77
7.0 16NOV77
7.6 16NOV77
ELEVATION (M)
5
4
3
2
1
0
-1
Station (meters)
0
3
6
9
12
16
TEST 5
Range
DATE
1.5 29DEC77
2.0 29DEC77
3.0 29DEC77
4.0 29DEC77
5.0 29DEC77
6.0 29DEC77
7.0 29DEC77
7.6 29DEC77
ELEVATION (M)
5
4
3
2
1
0
-1
Station (meters)
0
3
6
9
12
15


SHORELINE POSITION
VERTICAL DATUM IS SWL
HORIZONTAL DATUM IS
STATION 0
TEST 6
TEST 7
Range
DATE
1.5
2.0
3.0
4.0
5.0
6.0
7.0
7.6
3FEB78
13MAR78
ELEVATION (M)
Station (meters)

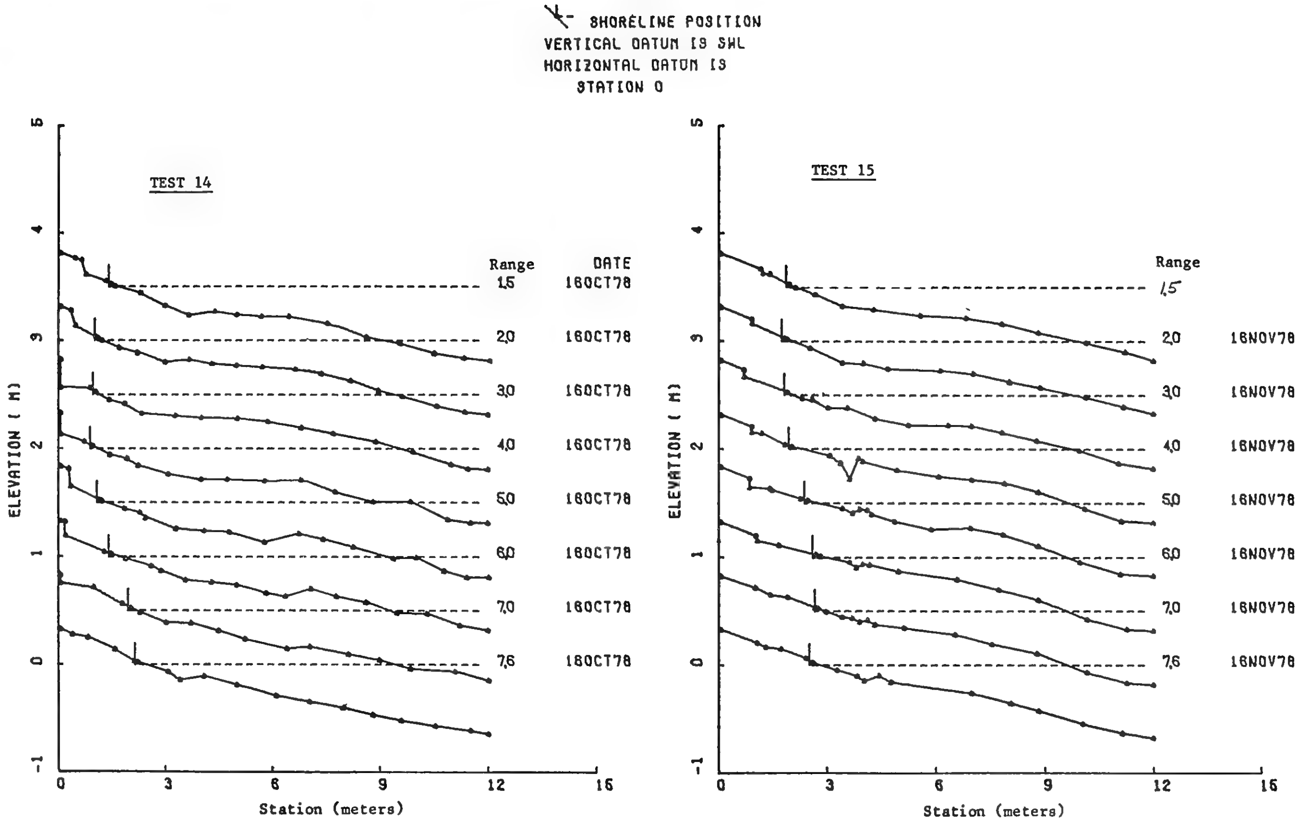

SHORELINE POSITION
VERTICAL DATUM IS SWL
HORIZONTAL DATUM IS STATION 0
TEST 8
TEST 9
Range
DATE
21APR78
19MAY78
ELEVATION (M)
Station (meters)



SHORELINE POSITION
VERTICAL DATUM IS SWL
HORIZONTAL DATUM IS
STATION 0
TEST 10
TEST 11
Range
DATE
1.5
2.0
3.0
4.0
5.0
6.0
7.0
7.6
23JUN78
20JUL78
21JUL78
ELEVATION (M)
Station (meters)



SHORELINE POSITION
VERTICAL DATUM IS SWL
HORIZONTAL DATUM IS
STATION 0
TEST 12
TEST 13
Range
DATE
1.5
2.0
3.0
4.0
5.0
6.0
7.0
7.6
23AUG78
18SEP78
ELEVATION (M)
Station (meters)


SHORELINE POSITION
VERTICAL DATUM IS SWL
HORIZONTAL DATUM IS
STATION 0
TEST 14
ELEVATION (M)
Range
DATE
1.5 16OCT78
2.0 16OCT78
3.0 16OCT78
4.0 16OCT78
5.0 16OCT78
6.0 16OCT78
7.0 16OCT78
7.6 16OCT78
Station (meters)
TEST 15
ELEVATION (M)
Range
1.5
2.0 16NOV78
3.0 16NOV78
4.0 16NOV78
5.0 16NOV78
6.0 16NOV78
7.0 16NOV78
7.6 16NOV78
Station (meters)

APPENDIX D

SELECTED BREAKER BAR AND WATERLINE PHOTOS

The following photos from 35-millimeter slides were taken at approximate run-hours 01, 08, 16, and 24. Figure 15 provides an explanation of features. The complete set of slides is available from CEIAC.

Figure D-1a.

Figure D-1b.

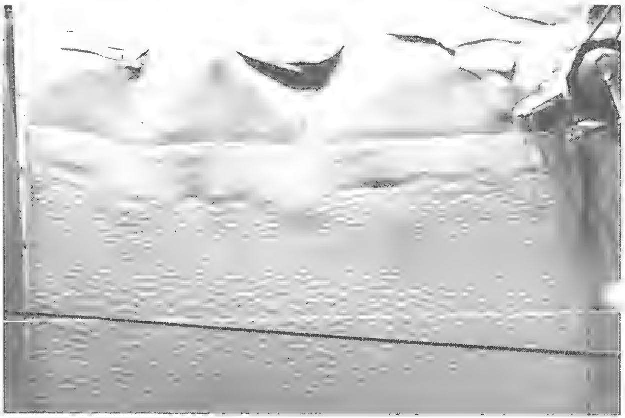


Figure D-1c.

Figure D-1d.

Figure D-2a.

Figure D-2b.

Figure D-2c.

Figure D-2d.

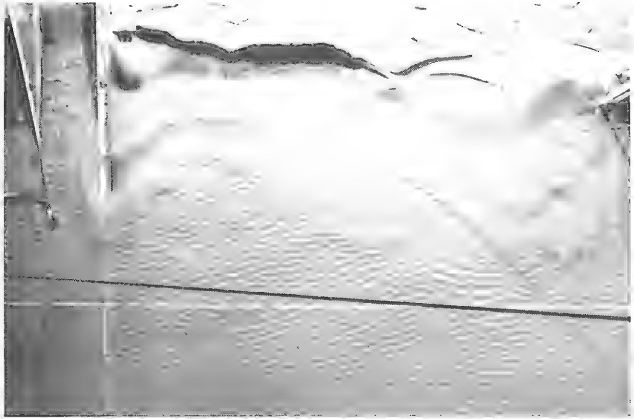


Figure D-3a.

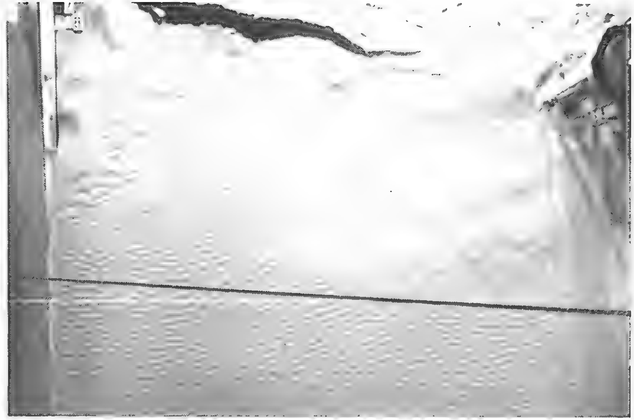


Figure D-3b.

Figure D-3c.

Figure D-3d.

Figure D-4a.

Figure D-4b.

Figure D-4c.

Figure D-4d.

Figure D-5a.

Figure D-5b.

Figure D-5c.

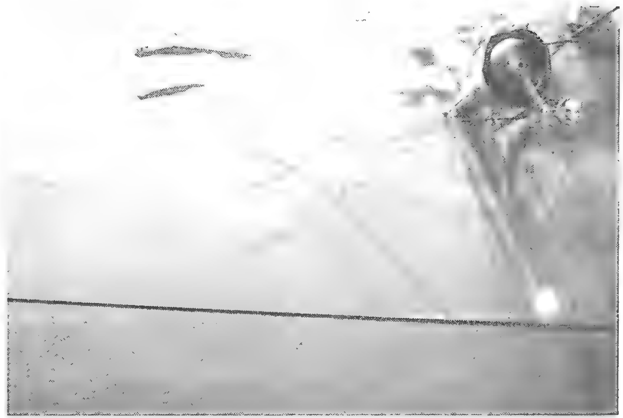


Figure D-5d.

Figure D-6a.

Figure D-6b.

Figure D-6c.

Figure D-6d.

Figure D-7a.

Figure D-7b.

Figure D-7c.

Figure D-7d.

Figure D-8a.

Figure D-8b.

Figure D-8c.

Figure D-8d.

Figure D-9a.

Figure D-9b.

Figure D-9c.

Figure D-9d.


Figure D-10a.

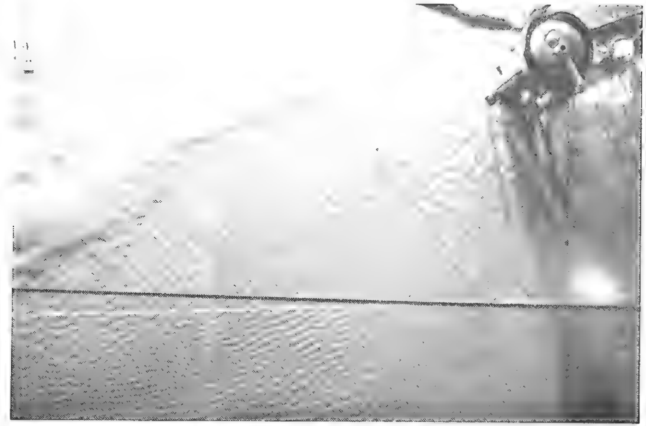


Figure D-10b.


Figure D-10c.


Figure D-10d.

Figure D-11a.

Figure D-11b.

Figure D-11c.

Figure D-11d.

APPENDIX E

HOURLY CYCLE CALCULATIONS

A listing of the program which calculates the values in this appendix, using the data in Appendix A, is available from CEIAC.

HOURLY CYCLE CALCULATIONS

TEST	WAVE RUN HR	DATA TIME MN	WAVE HEIGHT GAGE1 CM	WAVE HEIGHT GAGE2 CM	BREAKER ANGLES DEGREES		SXY N/M	PLB J/M/S
1	0	40	10.0	6.4	8	9	1.185	2.431
1	1	32	9.0	6.8	9	8	1.100	2.256
1	2	32	10.0	6.2	8	8	1.156	2.233
1	3	30	10.2	6.6	8	8	1.244	2.402
1	4	30	9.0	7.0	8	10	1.128	2.448
1	5	40	8.4	6.4	10	8	.965	2.095
1	6	40	9.2	6.8	8	8	1.128	2.178
1	7	30	10.2	6.4	8	7	1.214	2.199
1	8	30	9.8	6.0	7	9	1.100	2.124
1	9	30	9.0	7.2	9	8	1.156	2.372
1	10	30	9.4	7.2	8	9	1.214	2.490
1	11	30	10.2	5.6	9	9	1.100	2.388
1	12	30	10.0	6.2	9	7	1.156	2.233
1	13	30	10.6	6.2	7	6	1.244	1.953
1	14	30	9.2	8.0	6	6	1.304	1.891
1	15	30	9.6	7.4	6	8	1.274	2.153
1	16	30	9.6	7.4	8	8	1.274	2.459
1	17	30	11.0	6.2	8	8	1.304	2.517
1	18	30	10.0	6.8	8	8	1.244	2.402
1	19	30	10.6	6.0	8	6	1.214	2.053
1	20	30	10.0	5.6	6	7	1.072	1.684
1	21	30	9.0	7.0	7	7	1.128	1.907
1	22	30	10.2	6.6	7	7	1.244	2.103
1	23	30	10.0	5.8	7	8	1.100	1.992
1	24	30	10.6	6.0	8	6	1.214	2.053
2	0	30	10.4	5.8	7	7	1.156	1.955
2	1	30	10.4	5.8	7	7	1.156	1.955
2	2	30	10.4	6.4	7	8	1.244	2.252
2	3	30	10.0	6.4	8	8	1.185	2.289
2	4	30	10.4	6.8	8	6	1.304	2.204
2	5	30	10.4	6.4	6	8	1.244	2.103
2	6	30	9.2	5.6	8	7	.965	1.748
2	7	30	10.0	5.4	7	9	1.045	2.018
2	8	30	10.8	6.2	9	7	1.274	2.459
2	9	30	9.2	6.2	7	7	1.045	1.767
2	10	30	8.4	7.8	7	7	1.156	1.955
2	11	30	9.6	6.6	7	6	1.156	1.816
2	12	30	9.6	6.4	6	9	1.128	2.043
2	13	30	9.4	6.6	9	6	1.128	2.043
2	14	30	9.5	6.4	6	6	1.114	1.616
2	15	30	10.0	6.0	6	7	1.128	1.772
2	16	30	9.9	6.0	7	7	1.114	1.884
2	17	30	9.8	6.0	7	8	1.100	1.992
2	18	30	10.0	6.0	8	7	1.128	2.043
2	19	30	9.5	6.4	7	7	1.114	1.884
2	20	30	9.2	6.4	7	7	1.072	1.813
2	21	30	9.3	6.1	7	8	1.045	1.893
2	22	30	9.9	6.4	8	8	1.171	2.261
2	23	30	9.8	6.3	8	10	1.142	2.479
2	24	30	9.6	6.7	10	9	1.171	2.681
2	25	30	7.5	6.8	9	9	.901	1.956
2	26	30	10.2	6.6	9	9	1.244	2.699
2	27	30	9.8	6.1	9	9	1.114	2.418
2	28	30	10.1	6.2	9	6	1.171	2.120
2	29	0	9.7	6.8	6	2	1.200	1.161
3	0	30	13.2	12.3	8	8	2.268	3.793
3	1	30	13.1	11.6	8	8	2.128	3.559
3	2	30	12.7	12.4	8	9	2.197	3.903
3	3	30	12.4	15.1	9	9	2.638	4.959
3	4	30	13.1	14.6	9	8	2.676	4.754
3	5	30	13.2	14.7	8	8	2.715	4.541
3	6	30	12.8	13.3	8	7	2.376	3.727
3	7	28	13.6	12.9	7	7	2.449	3.587
3	8	30	11.0	13.9	7	2	2.162	2.039
3	9	30	9.7	15.3	2	6	2.180	1.828
3	10	30	11.8	14.4	6	5	2.394	2.758
3	11	30	11.3	14.0	5	5	2.232	2.338
3	12	30	11.3	15.0	5	5	2.412	2.527
3	13	30	13.2	13.2	5	4	2.431	2.292
3	14	30	11.4	10.6	4	5	1.688	1.592
3	15	30	12.8	14.5	5	9	2.599	3.807
3	16	30	12.0	12.2	9	7	2.043	3.417
3	17	30	12.1	11.6	7	7	1.959	2.869
3	18	30	12.4	12.2	7	6	2.111	2.872
3	19	30	12.8	11.8	6	10	2.111	3.530
3	20	30	13.1	13.2	10	11	2.412	5.284
3	21	30	12.1	11.3	11	8	1.910	3.788
3	22	30	12.9	11.8	8	2	2.128	2.229
3	23	30	13.2	13.6	2	4	2.505	1.576
4	0	30	9.6	11.5	8	8	1.793	3.290
4	1	30	10.4	13.2	8	6	2.243	3.604
4	2	30	11.1	13.8	6	6	2.497	3.441
4	3	30	11.0	15.4	6	8	2.806	4.510
4	4	30	11.9	16.2	8	6	3.179	5.109
4	5	30	11.0	14.2	6	8	2.557	4.109
4	6	30	10.8	13.8	8	7	2.437	4.194
4	7	30	10.2	12.8	7	6	2.130	3.179
4	8	30	11.8	12.5	6	9	2.378	4.092
4	9	30	11.2	13.2	9	7	2.397	4.399
4	10	30	10.0	12.7	7	8	2.075	3.571
4	11	30	10.0	13.7	8	7	2.262	3.893
4	12	30	10.3	12.3	7	9	2.057	3.774
4	13	30	10.1	12.5	9	8	2.057	4.008
4	14	30	9.4	12.0	8	8	1.844	3.384
4	15	30	9.5	12.8	8	8	2.002	3.675
4	16	30	9.9	13.3	8	8	2.167	3.977
4	17	30	9.4	11.8	8	7	1.810	3.115
4	18	30	8.8	11.8	7	7	1.709	2.746
4	19	30	8.8	12.4	7	6	1.810	2.701
4	20	30	10.4	13.7	6	6	2.339	3.223
4	21	30	10.4	12.4	6	8	2.093	3.364
4	22	30	8.5	11.3	8	8	1.579	2.897
4	23	30	8.1	11.6	8	6	1.563	2.511

HOURLY CYCLE CALCULATIONS

TEST	WAVE RUN HR	DATA TIME MN	WAVE HEIGHT GAGE1 CM	WAVE HEIGHT GAGE2 CM	BREAKER ANGLES DEGREES		SXY N/M	PLB J/M/S
5	0	30	6.0	6.9	4	2	.784	.591
5	1	30	7.0	8.1	2	2	1.074	.540
5	2	30	6.8	7.6	2	2	.977	.491
5	3	30	6.8	7.6	2	4	.977	.736
5	4	30	5.9	7.4	4	1	.833	.523
5	5	30	6.0	6.8	1	2	.772	.291
5	6	30	6.7	7.8	2	3	.991	.622
5	7	30	7.0	7.4	3	1	.977	.491
5	8	30	6.8	9.0	1	2	1.176	.443
5	9	30	6.4	8.0	2	2	.977	.491
5	11	30	6.2	8.0	2	1	.950	.358
5	12	30	6.4	7.7	1	4	.937	.588
5	13	30	6.6	8.0	4	5	1.004	1.134
5	14	30	7.0	7.8	5	4	1.032	1.166
5	15	30	6.2	8.2	4	2	.977	.736
5	16	30	7.4	7.7	2	3	1.074	.675
5	17	30	7.6	7.8	3	7	1.117	1.402
5	18	30	6.4	8.7	7	4	1.074	1.482
5	19	30	6.5	8.5	4	3	1.060	.932
5	21	30	7.2	6.8	3	10	.923	1.505
5	22	30	6.9	7.8	10	2	1.018	1.532
5	23	30	6.7	8.0	2	3	1.018	.639
6	0	30	10.1	5.7	13	8	2.067	2.654
6	1	30	9.6	5.8	8	10	1.964	2.164
6	2	30	10.2	5.5	10	11	2.041	2.621
6	3	30	9.8	5.5	11	11	1.939	2.606
6	4	30	9.6	6.6	11	10	2.173	2.790
6	5	30	9.2	6.0	10	9	1.913	2.225
6	6	30	8.5	6.8	9	9	1.939	2.136
6	7	30	8.3	6.7	9	7	1.863	1.827
6	8	30	9.3	6.1	7	8	1.964	1.806
6	9	30	8.8	6.0	8	10	1.814	1.999
6	10	30	8.4	6.6	10	7	1.863	1.940
6	11	30	9.4	6.1	7	9	1.990	1.951
6	12	30	9.1	6.1	9	9	1.913	2.109
6	13	30	8.5	6.8	9	9	1.939	2.136
6	14	30	9.1	6.0	9	6	1.888	1.736
6	15	30	8.8	6.4	6	11	1.913	1.992
6	16	30	9.3	6.5	11	9	2.067	2.529
6	17	30	9.6	7.1	9	12	2.310	2.965
6	18	30	9.6	6.7	12	6	2.200	2.425
6	19	30	9.3	6.4	6	7	2.041	1.628
6	20	30	8.8	6.5	7	11	1.939	2.136
6	21	30	8.0	6.7	11	7	1.790	1.972
6	22	30	9.2	6.1	7	7	1.939	1.664
6	23	30	9.3	6.1	7	5	1.964	1.446
7	0	25	11.4	13.0	11	12	4.505	6.013
7	1	30	12.1	11.2	12	10	4.108	5.248
7	2	30	12.4	10.6	10	12	4.003	5.114
7	3	30	11.1	11.6	12	10	3.900	4.981
7	4	30	9.3	10.3	10	11	2.907	3.547
7	5	30	9.1	9.6	11	19	2.646	4.585
7	6	46	8.8	11.7	19	10	3.180	5.331
7	7	30	8.9	11.0	10	9	2.997	3.311
7	8	30	8.5	9.9	9	12	2.562	3.176
7	9	30	8.4	9.4	12	12	2.398	3.337
7	10	30	9.7	11.2	12	10	3.306	4.223
7	11	30	9.7	9.2	10	11	2.703	3.298
7	12	30	9.8	10.4	11	12	3.088	4.121
7	13	30	10.0	10.4	12	11	3.149	4.203
7	14	30	9.4	11.2	11	11	3.211	4.102
7	15	30	8.6	9.4	11	12	2.452	3.273
7	16	30	9.6	11.4	12	9	3.337	4.072
7	17	30	9.0	11.8	9	11	3.274	3.806
7	18	30	9.8	10.7	11	12	3.180	4.245
7	19	30	8.6	9.9	12	12	2.590	3.605
7	20	30	9.3	10.1	12	11	2.848	3.801
7	21	30	10.0	11.8	11	11	3.596	4.594
7	22	30	9.7	10.8	11	11	3.180	4.063
7	23	30	8.8	10.2	11	13	2.732	3.803
8	0	30	10.4	11.7	9	9	3.696	3.871
8	1	30	9.5	9.3	9	12	2.675	3.263
8	2	30	10.6	9.1	12	11	2.937	3.920
8	3	30	9.7	9.3	11	12	2.732	3.646
8	4	30	9.1	9.6	12	13	2.646	3.834
8	5	30	8.8	9.9	13	12	2.646	3.834
8	6	30	8.2	11.5	12	11	2.937	3.920
8	7	30	7.2	10.6	11	8	2.398	2.649
8	8	30	7.6	11.2	8	12	2.675	3.109
8	9	30	8.5	10.4	12	10	2.703	3.453
8	10	30	9.4	12.6	10	11	3.663	4.469
8	11	30	8.9	12.5	11	10	3.466	4.228
8	12	30	8.4	12.6	10	10	3.337	3.880
8	13	30	8.2	12.8	10	15	3.337	4.836
8	14	30	7.9	12.2	15	14	3.057	5.125
8	15	30	8.1	11.8	14	8	2.997	3.828
8	16	30	8.6	11.1	8	10	2.937	3.076
8	17	30	8.2	11.1	10	15	2.819	4.084
8	18	30	8.0	11.7	15	11	2.937	4.423
8	19	30	9.3	11.0	11	13	3.119	4.341
8	20	30	7.7	12.0	13	10	2.937	3.920
8	21	30	7.9	12.6	10	12	3.180	4.063
8	22	30	8.6	12.0	12	10	3.211	4.102
8	23	30	9.5	11.7	10	11	3.401	4.149

HOURLY CYCLE CALCULATIONS

TEST	WAVE RUN HR	DATA TIME MN	WAVE HEIGHT GAGE1 CM	WAVE HEIGHT GAGE2 CM	BREAKER ANGLES DEGREES		SXY N/M	PLB J/M/S
9	0	30	9.8	12.0	15	15	3.115	4.920
9	1	30	11.7	9.4	15	13	2.918	4.308
9	2	30	12.0	9.4	13	13	3.002	4.121
9	3	30	12.1	10.5	13	15	3.348	4.942
9	4	30	11.2	9.5	15	14	2.809	4.291
9	5	30	11.7	9.6	14	14	2.974	4.390
9	6	30	11.1	8.9	14	14	2.622	3.871
9	7	30	10.6	9.6	14	14	2.675	3.948
9	8	30	10.8	8.6	14	14	2.467	3.642
9	9	30	11.0	9.1	14	15	2.648	4.046
9	10	30	9.8	7.6	15	14	1.985	3.032
9	11	30	10.2	8.6	14	14	2.317	3.420
9	12	30	11.2	8.7	14	13	2.596	3.698
9	13	30	11.8	9.4	13	15	2.946	4.349
9	14	30	11.7	9.0	15	15	2.809	4.436
9	15	30	10.8	9.9	15	13	2.809	4.146
9	16	30	11.2	11.2	13	14	3.289	4.685
9	17	30	11.3	10.0	14	16	2.974	4.697
9	18	30	11.4	10.1	16	17	3.030	5.251
9	19	30	12.1	9.0	17	15	2.918	4.908
9	20	30	11.5	7.8	15	15	2.442	3.856
9	21	30	11.4	8.3	15	15	2.544	4.018
9	22	30	11.1	9.8	15	15	2.863	4.522
9	23	30	12.2	10.2	15	16	3.289	5.363
10	0	30	14.4	18.3	11	14	8.092	11.725
10	1	30	15.3	18.0	14	14	8.392	13.591
10	2	30	14.3	17.1	14	14	7.461	12.084
10	3	30	15.3	18.2	14	16	8.493	14.715
10	4	30	14.7	18.0	16	16	8.092	14.932
10	5	30	13.8	17.4	16	16	7.367	13.594
10	6	30	15.3	17.7	16	17	8.241	15.670
10	7	30	15.6	17.9	17	16	8.493	16.148
10	8	30	14.7	18.5	16	15	8.341	14.923
10	9	30	14.4	18.2	15	15	8.043	13.935
10	10	30	13.8	18.3	15	16	7.798	13.951
10	11	30	14.7	17.9	16	15	8.043	14.389
10	12	30	15.3	17.3	15	18	8.043	15.292
10	13	30	14.4	18.0	18	16	7.944	15.549
10	14	30	15.0	21.0	16	15	9.808	17.547
10	15	30	13.7	19.5	15	15	8.341	14.453
10	16	30	14.1	19.2	15	14	8.392	14.066
10	17	30	14.4	18.8	14	16	8.341	14.453
10	18	30	14.1	19.8	16	16	8.697	16.048
10	19	30	13.7	20.7	16	16	8.955	16.525
10	20	30	13.5	19.5	16	16	8.241	15.207
10	21	30	14.3	19.2	16	17	8.493	16.148
10	22	30	13.7	18.5	17	16	7.846	14.919
10	23	30	14.6	18.0	16	15	8.043	14.389
12	0	30	9.7	5.3	21	21	2.511	4.336
12	1	30	9.5	5.4	21	22	2.477	4.375
12	2	30	10.3	4.5	22	15	2.444	3.737
12	3	30	10.8	4.7	15	18	2.681	3.669
12	4	30	10.3	10.3	18	21	4.735	7.617
12	5	30	10.3	10.3	21	24	4.735	8.732
12	6	30	9.5	9.5	24	17	4.028	6.798
12	7	30	10.3	10.3	17	21	4.735	7.429
12	8	30	9.6	5.7	21	19	2.612	4.305
12	9	30	11.0	4.7	19	17	2.750	4.096
12	10	30	10.5	4.9	17	23	2.646	4.361
12	11	30	10.3	5.2	23	22	2.681	4.943
12	12	30	11.3	4.3	22	16	2.716	4.260
12	13	30	10.1	4.9	16	18	2.511	3.537
12	14	30	11.4	4.9	18	22	2.965	4.886
12	15	30	9.9	5.3	22	22	2.578	4.654
12	16	30	9.3	6.4	22	22	2.750	4.965
12	17	30	9.2	6.1	22	18	2.612	4.305
12	18	30	9.6	5.6	18	21	2.578	4.147
12	19	30	9.9	6.0	21	21	2.821	4.871
12	20	30	9.7	6.5	21	20	2.928	4.942
12	21	30	9.5	5.8	20	18	2.612	4.098
12	22	30	9.1	4.8	18	19	2.156	3.296
12	23	30	9.5	5.0	19	20	2.346	3.774
13	0	30	6.6	7.6	15	15	2.406	3.113
13	1	30	6.7	8.0	15	18	2.578	3.661
13	2	43	6.1	7.6	18	16	2.239	3.273
13	3	30	6.2	7.8	16	19	2.339	3.516
13	4	30	7.2	7.0	19	19	2.406	3.916
13	5	30	6.7	6.8	19	12	2.174	2.905
13	6	32	6.8	6.9	12	13	2.239	2.423
13	7	30	7.1	6.8	13	15	2.305	2.788
13	8	30	6.3	7.3	15	15	2.207	2.855
13	9	30	6.2	7.0	15	20	2.079	3.125
13	10	30	6.6	6.6	20	14	2.079	3.039
13	11	30	7.2	6.5	14	16	2.239	2.898
13	12	30	7.1	6.4	16	16	2.174	2.996
13	13	30	7.0	6.6	16	18	2.207	3.226
13	14	30	7.1	6.8	18	16	2.305	3.369
13	15	30	6.8	6.8	16	15	2.207	2.948
13	16	30	6.5	6.7	15	12	2.079	2.426
13	17	30	6.2	6.7	12	16	1.985	2.401
13	18	30	6.8	7.0	16	18	2.272	3.321
13	19	30	6.5	7.1	18	14	2.207	3.041
13	20	30	5.9	7.8	14	12	2.239	2.518
13	21	30	5.8	8.2	12	13	2.339	2.530
13	22	30	5.7	7.6	13	11	2.110	2.194
13	23	30	6.2	7.9	11	11	2.372	2.263

HOURLY CYCLE CALCULATIONS

TEST	WAVE RUN HR	DATA TIME MN	WAVE HEIGHT GAGE1 CM	WAVE HEIGHT GAGE2 CM	BREAKER ANGLES DEGREES		SXY N/M	PLB J/M/S
14	0	30	13.2	17.4	27	28	11.172	25.790
14	1	30	15.0	16.8	28	28	12.065	28.318
14	2	30	15.6	14.7	28	23	10.954	23.576
14	3	30	15.6	16.2	23	28	12.065	25.968
14	4	30	14.1	16.8	28	29	11.392	27.176
14	5	30	14.4	17.0	29	29	11.764	28.512
14	6	30	15.0	18.2	29	31	13.151	32.873
14	7	30	15.6	17.7	31	31	13.230	34.067
14	8	30	14.0	18.3	31	29	12.448	31.115
14	9	30	14.7	16.8	29	30	11.839	29.145
14	10	30	14.7	18.2	30	30	12.914	32.282
14	11	30	14.4	16.8	30	32	11.614	29.905
14	12	30	14.1	16.1	32	30	10.882	28.019
14	13	30	14.6	15.0	30	32	10.454	26.917
14	14	30	14.6	15.6	32	29	10.882	27.611
14	15	30	14.7	15.2	29	30	10.667	26.259
14	16	30	13.8	16.8	30	30	11.172	27.926
14	17	30	15.8	15.9	30	32	11.989	30.872
14	18	30	14.1	17.7	32	33	12.065	32.409
14	19	30	14.3	16.8	33	33	11.540	31.422
14	20	30	13.2	14.4	33	32	9.089	24.414
14	21	30	15.2	17.4	32	28	12.680	31.696
14	22	40	14.3	16.2	28	31	11.099	27.324
14	23	30	15.0	15.0	31	31	10.738	27.649
15	0	30	13.8	18.0	19	16	10.311	14.199
15	1	30	13.8	17.6	16	16	10.053	12.690
15	2	30	12.6	17.6	16	20	9.299	13.160
15	3	30	13.7	16.2	20	18	9.116	13.590
15	4	30	14.0	15.8	18	16	9.055	12.123
15	5	30	13.4	17.0	16	17	9.423	12.256
15	6	30	13.4	16.4	17	19	9.055	12.813
15	7	30	14.6	16.6	19	19	10.053	14.988
15	8	30	13.2	17.0	19	19	9.299	13.864
15	9	30	13.9	16.8	19	19	9.610	14.327
15	10	30	13.8	16.4	19	20	9.299	14.215
15	11	30	13.4	16.6	20	19	9.299	14.215
15	12	30	12.8	17.0	19	19	9.055	13.500
15	13	30	13.2	15.9	19	20	8.634	13.199
15	14	30	14.4	17.0	20	18	10.053	14.988
15	15	30	13.2	18.3	18	18	10.117	14.317
15	16	30	12.5	16.8	18	18	8.753	12.387
15	17	30	12.6	16.8	18	23	8.813	14.134
15	18	30	13.4	15.0	23	18	8.224	13.189
15	19	30	13.1	17.3	18	16	9.423	12.616
15	20	30	13.1	15.8	16	19	8.516	11.727
15	21	30	12.0	16.5	19	20	8.282	12.660
15	22	30	12.8	18.3	20	21	9.862	15.816
15	23	30	13.2	15.6	21	21	8.457	13.879

APPENDIX F

DAILY CYCLE CALCULATIONS

A listing of the program which calculates the values in this appendix, using the data in Appendix A, is available from CEIAC.

DAILY CYCLE CALCULATIONS

TEST	RUN FROM HR	TIME TO HR	SXY N/M	PLA J/M/S	IL N/S	KS M/S	KP
1	0	1	1.185	2.431	.4448	.3753	.1830
1	1	2	1.100	2.256	.5090	.4627	.2256
1	2	5	1.176	2.361	.5667	.4819	.2400
1	5	9	1.102	2.149	.5591	.5074	.2601
1	9	14	1.174	2.287	.6198	.5278	.2710
1	14	20	1.269	2.246	.6726	.5301	.2995
1	20	25	1.152	1.948	.6534	.5673	.3354
2	0	6	1.215	2.127	.6697	.5512	.3149
2	6	9	1.095	2.075	.6771	.6186	.3263
2	9	14	1.123	1.925	.7275	.6479	.3779
2	14	20	1.116	1.865	.6775	.6069	.3633
2	20	25	1.120	2.225	.7028	.6273	.3158
2	25	30	1.126	2.071	.6805	.6045	.3286
3	0	4	2.308	4.054	.8624	.3737	.2127
3	4	8	2.554	4.152	.8501	.3328	.2047
3	8	12	2.242	2.241	.9322	.4158	.4160
3	12	16	2.283	2.555	.7475	.3275	.2926
3	16	20	2.056	3.172	.8111	.3946	.2557
3	20	24	2.239	3.219	.8340	.3725	.2591
4	0	4	2.335	3.711	.7290	.3123	.1964
4	4	8	2.576	4.148	.6484	.2595	.1612
4	8	12	2.278	3.989	.5906	.2593	.1481
4	12	16	1.990	3.710	.5857	.2943	.1578
4	16	20	1.874	3.135	.6079	.3244	.1939
4	20	24	1.893	2.999	.5313	.2806	.1772
5	0	4	.953	.589	.5659	.5937	.9602
5	4	8	.893	.482	.8414	.9420	1.7465
5	8	12	1.034	.431	.8260	.7985	1.9178
5	12	16	.988	.906	.7321	.7413	.8080
5	16	20	1.082	1.123	.8612	.7963	.7671
5	20	24	.987	1.225	.6999	.7095	.5712
6	0	4	2.003	2.511	1.0014	.5000	.3988
6	4	8	1.972	2.245	.9390	.4761	.4184
6	8	12	1.908	1.924	.9236	.4841	.4800
6	12	16	1.913	1.993	1.0206	.5334	.5120
6	16	20	2.155	2.387	1.0898	.5057	.4566
6	20	24	1.908	1.805	1.0051	.5269	.5569
7	0	2	4.307	5.631	1.2751	.2961	.2265
7	2	4	3.951	5.048	.9934	.2514	.1968
7	4	6	2.777	4.066	.7018	.2527	.1726
7	6	8	3.089	4.321	.7512	.2432	.1738
7	8	12	2.742	3.496	.6901	.2516	.1974
7	12	16	2.975	3.925	.6227	.2093	.1587
7	16	20	3.095	3.932	.6388	.2064	.1625
7	20	24	3.089	4.065	.5560	.1800	.1368
8	0	4	3.010	3.675	.7117	.2364	.1937
8	4	8	2.657	3.560	.3781	.1423	.1062
8	8	12	3.127	3.815	.3280	.1049	.0860
8	12	16	3.182	4.417	.2273	.0714	.0515
8	16	20	2.953	3.981	.1853	.0628	.0466
8	20	24	3.182	4.059	.2372	.0745	.0585
9	0	4	3.096	4.573	.6530	.2109	.1428
9	4	8	2.770	4.125	.4695	.1695	.1138
9	8	12	2.354	3.535	.5962	.2532	.1686
9	12	16	2.790	4.157	.4646	.1665	.1118
9	16	20	3.053	4.885	.4565	.1495	.0934
9	20	22	2.493	3.937	.4967	.1993	.1262
9	22	24	3.076	4.943	.4967	.1615	.1005
10	0	12	8.071	14.138	1.0045	.1245	.0710
10	12	16	8.534	15.710	1.0898	.1277	.0694
10	16	20	8.596	15.273	1.0984	.1278	.0719
10	20	24	8.156	15.166	1.1614	.1424	.0766
12	0	4	2.528	4.029	1.1593	.4585	.2877
12	4	8	4.559	7.644	1.6794	.3684	.2197
12	8	12	2.672	4.426	1.6686	.6244	.3770
12	12	16	2.692	4.334	1.7378	.6455	.4010
12	16	20	2.690	4.572	1.7681	.6572	.3867
12	20	24	2.511	4.027	1.7838	.7105	.4429
13	0	4	2.390	3.391	1.3094	.5478	.3862
13	4	8	2.281	3.008	1.3057	.5724	.4341
13	8	10	2.143	2.990	1.1497	.5365	.3845
13	10	14	2.175	3.040	1.1015	.5065	.3624
13	14	18	2.144	2.786	1.1222	.5234	.4028
13	18	22	2.264	2.853	1.1704	.5169	.4103
13	22	24	2.241	2.228	1.1614	.5182	.5212
14	0	4	11.564	25.913	3.1989	.2766	.1234
14	4	8	12.384	30.657	3.1000	.2503	.1011
14	8	12	12.204	30.612	3.2869	.2693	.1074
14	12	16	10.721	27.201	3.3434	.3119	.1229
14	16	20	11.692	30.657	3.1414	.2687	.1025
14	20	24	10.901	27.771	3.6925	.3387	.1330
15	0	4	9.695	13.410	2.2938	.2366	.1711
15	4	8	9.396	13.045	2.1264	.2263	.1630
15	8	12	9.377	14.156	2.4492	.2612	.1730
15	12	16	9.465	14.001	2.6632	.2814	.1902
15	16	20	8.803	13.082	2.9209	.3318	.2233
15	20	24	8.779	13.521	2.8480	.3244	.2106

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