WINDSPEED ADJUSTMENT AND WAVE GROWTH

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WINDSPEED ADJUSTMENT AND WAVE GROWTH

DESCRIPTION

The methodologies presented in this ACES application provide quick and simple estimates for wave growth over open-water and restricted fetches in deep and shallow water. Also, improved methods (over those given in the *Shore Protection Manual* (SPM), 1984) are included for adjusting the observed winds to those required by wave growth formulas. Because of the complexity of this methodology and the input requirements, familiarization with the *Technical Reference* for this application is strongly recommended.

PROCEDURE

This section provides instructions for running this application in the **Single Case** and **Multiple Case** modes.

Single Case Mode

The bulleted items listed below provide instructions for accessing the application.

- Press F1 on the Main Menu to select Single Case Mode.
- Fill in the highlighted input fields on the General Specifications screen (or leave the default values). Press F1 when all data on this screen are correct.
- Press F1 on the Functional Area Menu to select Wave Prediction.
- Press F1 on the Wave Prediction Application Menu to select Windspeed Adjustment and Wave Growth.

Input

For the **Single Case Mode**, data input for this application is accomplished through one main input screen, plus some support screens (for restricted fetch geometry), and several *pop-up windows* (hereafter called *requestors* in this document) that request additional specific data or choices between menu-style items. These are described in the following section.

Main Input Screen

The main input screen for the **Single Case Mode** is shown in Figure 1-1-1. It is used for entering data values and corresponding units for six *specific parameters*, and choosing between six *Wind Observation Types* and two *Wind Fetch Options*. Final results from the computations are displayed on this screen.

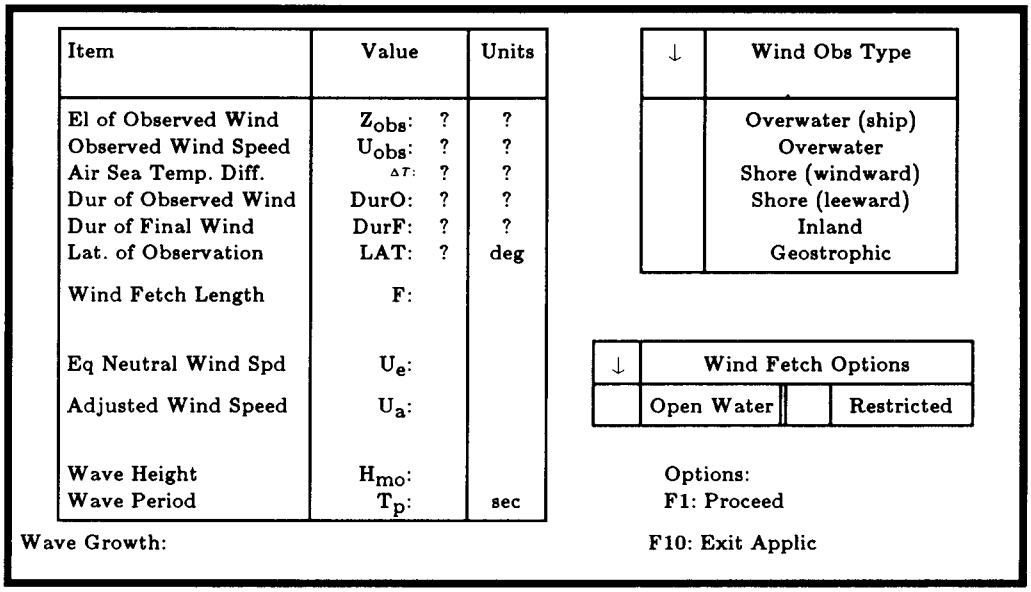

Figure 1-1-1. Main Input Screen - Single Case Mode

Specific Parameters

The following list describes the specific input parameters on the main input screen (indicated by ? in Figure 1-1-1) with corresponding units and range of data recognized by this application:

Item	Symbol	Units	Data Range
Elevation of observed wind	Z_{obs}	ft, m	1.0 to 5000.0
Observed wind speed	U_{obs}	ft/sec, mph, m/sec, knots	0.1 to 200.0
Air-sea temperature difference	ΔT	°C, °F	-100.0 to 100.0
Duration of observed wind	*DurO*	hr, min, sec	0.1 to 86400.0
Duration of final wind	*DurF*	hr, min, sec	0.1 to 86400.0
Latitude of wind observation	*LAT*	deg	0.0 to 180.0

Wind Observation Type

Select a *Wind Observation Type* by moving the cursor to the desired type and pressing ⊠. The options available are:

Location of Observation	Wind Direction
Over water (shipboard)	
Over water (not shipboard)	
At shoreline (windward)	Offshore to onshore
At shoreline (leeward)	Onshore to offshore
Over land	
Geostrophic	

Wind Fetch Options

Select a *Wind Fetch Option* by moving the cursor to the desired option and pressing ⊠. The options available are:

- Open Water
- Restricted (Fetch)

Selecting either of these options will display *requestors* for further input. The format and data requirements of these requestors are described below.

Open-Water Wave Growth Equations Requestor

The Open-Water Wave Growth Equations *requestor* for the **Single Case Mode** is shown in Figure 1-1-2. It requests choosing between the deep- and shallow-water wave growth equations and values for the length and units of wind fetch.

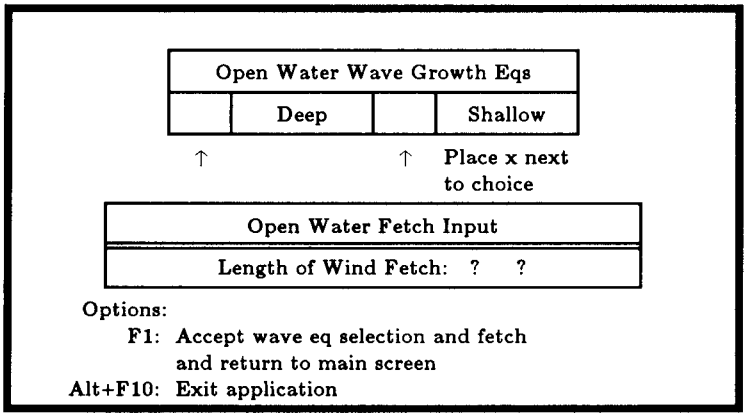

Figure 1-1-2. Open-Water Requestor - Single Case Mode

Select a *Wave Growth Equation* by moving the cursor to the desired type and pressing [x]. The options available are:

- Deep (deepwater wave growth relationships).
- Shallow (shallow-water wave growth relationships).

When the *Shallow* option is chosen, another *requestor* will appear on the screen asking for the value and units of the average depth of the fetch. See the section titled *Average Depth of Fetch Requestor* and Figure 1-1-3 for more details.

The following list summarizes the requested input (indicated by ? in Figure 1-1-2) for the Open-Water Wave Growth Equations *requestor*. The list identifies the specific input parameter, units, and range of data recognized by this application:

Item	Symbol	Units	Data Range
Length of wind fetch	*F*	ft, m, mi, km	0.0 to 9999.0

When all data on the Open-Water Wave Growth Equations *requestor* are correct, press one of the following keys to select the appropriate action:

[F1] Accept wave eq selection and fetch and return to main screen.
[Alt] [F10] Exit application.

Average Depth of Fetch Requestor

The Average Depth of Fetch *requestor* is shown in Figure 1-1-3 and appears when the shallow-water wave growth equations are selected.

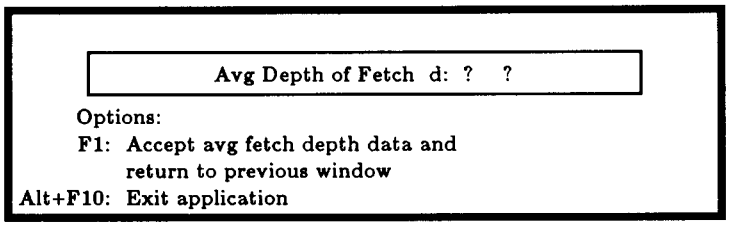

Figure 1-1-3. Average Depth of Fetch Requestor - Single Case Mode

The following list summarizes the requested input (indicated by ? in Figure 1-1-3) for this *requestor*. The list identifies the specific input parameter, units, and range of data recognized by this application:

Item	Symbol	Units	Data Range
Average depth of fetch	*d*	ft, m	0.1 to 10000.0

When the data for this *requestor* are correct, press one of the following keys to select the appropriate action:

[F1] Accept avg fetch depth data and return to previous window.

[Alt] [F10] Exit application.

Restricted Fetch Requestor

The data requirements for the Restricted Fetch approach are substantially larger than the simpler Open-Water fetch approach. In addition to choosing between the deepwater and shallow-water wave growth equations, the wind approach direction must be specified as well as an accurate description of the geometry of the subject basin. Radial fetch lengths measured (clockwise from north) from the point of interest are used to describe the geometry of the basin. The

conventions and notations associated with data solicited by this group of *requestors* as well as the remainder of the data for the Fetch Geometry Data Entry Screen which follows are presented in Figure 1-1-4.

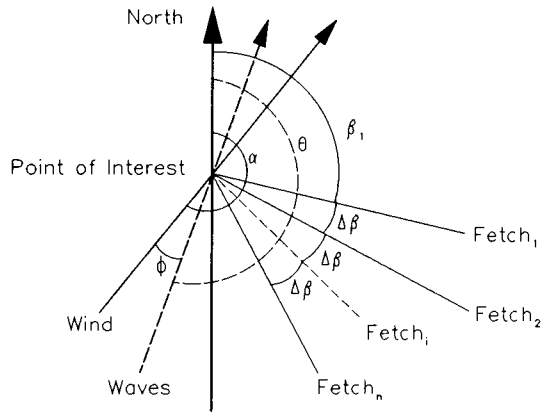

Figure 1-1-4. Restricted Fetch Conventions

The Restricted Fetch *requestor* for the **Single Case Mode** is shown in Figure 1-1-5. It requests a value for the wind approach direction and a choice between the deepwater and shallow-water wave growth equations. It also requests a choice between entering all of the fetch geometry interactively or reading the fetch geometry from a data file.

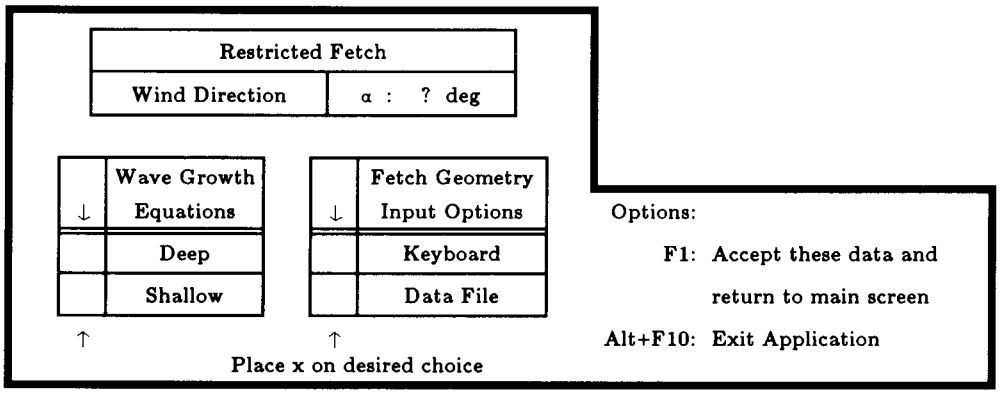

Figure 1-1-5. Restricted Fetch Requestor - Single Case Mode

The following list summarizes the requested input (indicated by ? in Figure 1-1-5) for the Restricted Fetch *requestor*. The list identifies the specific input parameter, units, and range of data recognized by this application:

Item	Symbol	Units	Data Range
Wind Direction	α	deg	0 to 360

Next, select a *Wave Growth Equation* by moving the cursor to the desired type and pressing [x]. The options available are:

- Deep (deepwater wave growth relationships).
- Shallow (shallow-water wave growth relationships).

When the *Shallow* option is chosen, another *requestor* will appear on the screen requesting the average depth of the fetch. See the section titled *Average Depth of Fetch Requestor* and Figure 1-1-3 for data input details.

Finally, select a *Fetch Geometry Input Option* by moving the cursor to the desired option and pressing [x]. The options available are:

- Keyboard (geometry keyed in now).
- Data File (geometry read from file).

Selecting either of these options will display *requestors* for further input. The format and data requirements of these requestors are described below.

Keyboard Data Entry Requestor

The Keyboard Data Entry *requestor* is shown in Figure 1-1-6.

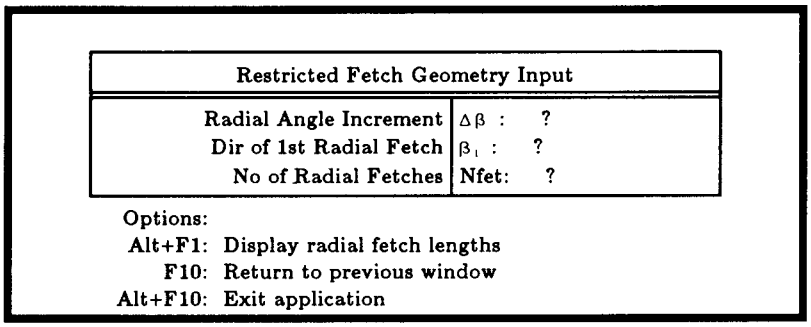

Figure 1-1-6. Keyboard Data Entry Requestor - Single Case Mode

The following list summarizes the requested input (indicated by ? in Figure 1-1-6) for the Restricted Fetch Keyboard Data Entry *requestor*. The list identifies the specific input parameter, units, and range of data recognized by this application:

Item	Symbol	Units	Data Range		
Radial Angle Increment	$\Delta\beta$	deg	1.0	to	180.0
Dir of 1st Radial Fetch	β_1	deg	0.0	to	360.0

NOTE: β_1 is measured clockwise from north.

No of Radial Fetches	Nfet		2	to	360

NOTE: The total angular coverage of the radials must not exceed 360 *deg*.

When the data on this *requestor* are correct, press one of the following keys to select the appropriate action:

[Alt] [F1] Display radial fetch lengths.

[F10] Return to previous window.

[Alt] [F10] Exit application.

When the [Alt] [F1] option is selected, a Fetch Geometry Data Entry Screen (described below) will appear to allow input of fetch lengths.

Fetch Geometry Data Entry Screen

The majority of the data describing the restricted fetch geometry are collected on this data entry screen. A total of *Nfet* individual radial fetch lengths must be provided at their corresponding angles (measured clockwise from north and prescribed by β_1, $\Delta\beta$). The radial fetch index numbers and corresponding angles are displayed as an input aid on this screen. The units and allowed range of radial fetch values considered by this application are tabulated below:

Item	Symbol	Units	Data Range		
Fetch Length		ft, m, mi, km	0.0	to	9999.0

Up to 20 values may be input and displayed on this screen. If more that 20 radial fetch values are specified (*Nfet > 20*), the screen will subsequently be re-invoked for the next 20 values and so on. When the data on this screen are correct, press one of the following keys to select the appropriate action:

[F1] Accept data.

NOTE: The next 20 values may then be input when the screen is re-invoked in this fashion. If all (*Nfet*) values for radial fetch length have been specified, this action will signify acceptance of the data as entered and return to the main input screen (Figure 1-1-1).

[Alt] [F10] Exit application.

Data File Entry Requestor

As an alternative to interactively keying in the restricted fetch geometry data, a data file containing the information may be specified. This requestor provides a mechanism for declaring the name of the data file which contains the restricted fetch geometry. The format of the Data File Entry *requestor* is shown in Figure 1-1-7.

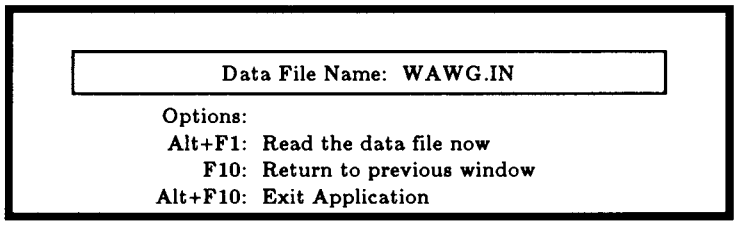

Figure 1-1-7. Data File Entry Requestor - Single Case Mode

Use this *requestor* to access and/or modify fetch geometry data saved in an external file. Typically this data file has been created with a text editor or saved as a trace file (default name **TRACE.OUT**) from a previous execution of this application. The format and contents of a trace file produced by this application match exactly the requirements of this input file. The default input file name is **WAWG.IN**, but other filenames (including pathname) are acceptable. For more information on files, see the section of this manual entitled, *General Instructions and Information.*

After specifying the name of the file, press one of the following keys to select the appropriate action:

(Alt) (F1) Read the data file now.

NOTE: Use this option to open and read the data file at this time. Upon successfully reading the file, the Fetch Geometry Data Entry Screen is displayed and shows the restricted fetch geometry read from the file. The data may then be edited or accepted using procedures described in the previous section.

(F10) Return to previous window.

NOTE: Use this option to return to the previous window without accepting any fetch geometry data.

(Alt) (F1) Exit application.

Finally, the application is executed with the selected options and data by pressing (F1) from the main input screen (Figure 1-1-1). Input and output data are displayed on the screen using the original units for related parameters. The one exception is the wave height (H_{m_0}), which is reported in the final system of units. The following section entitled **Output** summarizes the parameters generated by this application.

After completion of the computations, press one of the following keys to select the appropriate action:

(F1) Solve a new case.

(F3) Send a summary of this case to the print file or device.

(F10) Exit this application and return to the Wave Prediction Application Menu.

Output

Results from this application are displayed on the main input screen in **Single Case Mode**. The report also includes the original input values. The following data are always reported:

Item	Symbol	English Units	Metric Units
Equivalent neutral wind speed	U_e	ft/sec, mph, knots	m/sec
Adjusted wind speed	U_a	ft/sec, mph, knots	m/sec
Wave height	H_{m0}	ft	m
Peak wave period	T_p	sec	sec

In addition to the above output, a message is provided indicating whether deep- or shallow-water equations were employed and whether the wave growth was ultimately determined by fetch-limited, duration-limited, or fully developed criteria.

If the restricted fetch approach was selected, the individual radial fetch data are not reported as output. However, the resultant maximized fetch as well as directional data for wind and wave growth are also displayed:

Item	Symbol	English Units	Metric Units
Fetch Length	F	ft, mi	m, km
Wind Direction	α	deg	deg
Wave Direction	Θ	deg	deg

Multiple Case Mode

The bulleted items listed below provide instructions for accessing the application.

- Press [F2] on the Main Menu to select Multiple Case Mode.
- Fill in the highlighted input fields on the General Specifications screen (or leave the default values). Press [F1] when all data on this screen are correct.
- Press [F1] on the Functional Area Menu to select Wave Prediction.
- Press [F1] on the Wave Prediction Application Menu to select Windspeed Adjustment and Wave Growth.

Input

As in most ACES applications, the data requirements for the **Multiple Case Mode** are essentially the same as for **Single Case Mode**, but are organized in a different fashion. Data entry is accomplished through several screens and *requestors* which are described in the following sections.

Main Input Screen

The main input screen for the **Multiple Case Mode** is shown in Figure 1-1-8. It facilitates choosing a *Wind Observation Type* and *Wind Fetch Option* for all of the computations which follow.

	Type of Observation	Wind Direction
	Over Water (shipboard)	
	Over Water	
	Shoreline (windward)	Offshore->onshore
	Shoreline (leeward)	Onshore->offshore
	Over Land	
	Geostrophic	

↑ Place x next to choice

Wind Fetch Options	
	Open Water
	Restricted

Options:
F1: Proceed
F10: Exit Application

Figure 1-1-8. Main Input Screen - Multiple Case Mode

Wind Observation Type

Select a *Wind Observation Type* by moving the cursor to the desired type and pressing ⊠. The options available are:

Location of Observation	Wind Direction
Over water (shipboard)	
Over water (not shipboard)	
At shoreline (windward)	Offshore to onshore
At shoreline (leeward)	Onshore to offshore
Over Land	
Geostrophic	

Wind Fetch Options

Select a *Wind Fetch Option* by moving the cursor to the desired option and pressing ⊠. Two options are available:

- Open Water
- Restricted (Fetch)

Selecting either of these options will display appropriate *requestors* for further input. The format and data requirements of these *requestors* are described below.

Open-Water Wave Growth Equations Requestor

The Open-Water Wave Growth Equations *requestor* for the **Multiple Case Mode** is shown in Figure 1-1-9. It provides a mechanism for choosing between the deepwater and shallow-water wave growth equations.

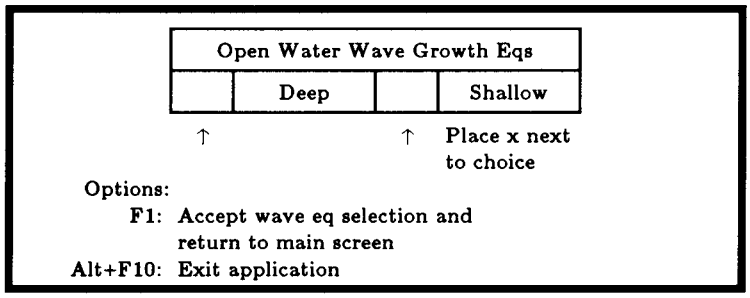

Figure 1-1-9. Open-Water Requestor - Multiple Case Mode

Select a wave growth equation by moving the cursor to the desired type and pressing [x]. Two options are available:

- Deep (deepwater wave growth relationships).
- Shallow (shallow-water wave growth relationships).

After selecting a wave growth equation, press [F1] to return to the **Multiple Case Mode** main input screen (Figure 1-1-8) and press [F1] to bring up the *specific parameters* data entry screen.

Restricted Fetch Requestor

The Restricted Fetch *requestor* for the **Multiple Case Mode** is shown in Figure 1-1-10. It requests a choice between the deepwater and shallow-water wave growth equations and a choice for the preferred mode of entering data for the restricted fetch geometry.

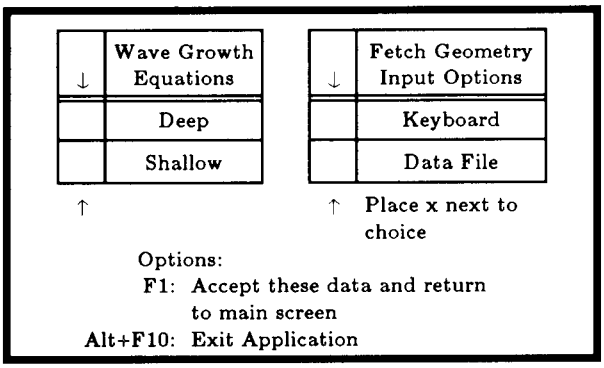

Figure 1-1-10. Restricted Fetch Requestor - Multiple Case Mode

Select a *Wave Growth Equation* by moving the cursor to the desired type and pressing [x]. Two options are available:

- Deep (deepwater wave growth relationships).
- Shallow (shallow-water wave growth relationships).

Finally, select a *Fetch Geometry Input Option* by moving the cursor to the desired option and pressing [X]. The options available are:

- Keyboard (geometry keyed in now).
- Data File (geometry read from a file).

Selecting either of these options will display *requestors* for further input. The two corresponding *requestors* (Keyboard Data Entry and Data File Entry) have been described in the **Single Case Mode** portion of this document. Refer to those earlier sections for details.

After completing input on the *requestors*, return to the main input screen (Figure 1-1-8) and press [F1] to proceed to the *specific parameters* data entry screen and follow the steps outlined below for entering data on this screen.

Specific Parameters Data Entry Screen

1. Move the cursor to select a variable on this screen (the selected variable name blinks). The current set of values for the variable is displayed on the right portion of the screen. When all variable sets are correct, go to Step 3.

2. Enter a set of values for the subject variable by following one of the input methods:
   a. Press [R] to select random method. Enter up to 20 values constituting a set for this variable (one in each field) on the right side of the screen. The set of 20 values originally displayed (first execution) in these fields contains the "delimiting" value, which "delimits" or "ends" the set. The "delimiting" value is *not* included as a member in the set unless it is the sole member.
   b. Press [I] to select incremental method. Fill in the fields for minimum, maximum, and increment values for this variable on the right side of the screen. In this method, the members of the set include all values from the minimum to the maximum (both inclusive) at the specified increment.

The units field should also be specified for the variable regardless of input method. All members of a set of values for a subject variable are assigned the specified units. When all data are correct for the subject variable, press [F10] to return to Step 1. Errors are reported at the bottom of the screen and are corrected by pressing [F1] to allow respecification of the data for the subject variable.

3. Press [F1] to process the cases resulting from the combinations of the sets of data for all variables. The summary of each case will be sent to the print file or device. The screen will display the total number of cases to be processed as well as report progress. Errors are reported at the bottom of the screen and are corrected by pressing [F1] to allow respecification of variable sets.

4. Press one of the following keys to select the appropriate action:

   [F1] Return to Step 1 to specify new sets.

   [F10] Exit this application and return to the Wave Prediction Application Menu.

Output

Results from using this application in **Multiple Case Mode** are written to the Print File or Device. The format and contents reported are described in the Output section of the **Single Case Mode** portion of this document. Refer to that section for details. The primary difference is that the reported data are not displayed on the screen, but are always written to the Print File or Output Device.

EXAMPLE PROBLEMS

Example 1 - Offshore to Onshore Winds - Open-Water Fetch - Shallow-Water Wave Equations

Input

Main Input Screen

Item	Symbol	Value	Units
Elevation of observed wind	Z_{obs}	25	ft
Observed wind speed	U_{obs}	45	mph
Air-sea temperature difference	ΔT	0	
Duration of observed wind	DUR	3	hr
Duration of final wind	DUR	3	hr
Latitude of wind observation	LAT	30	deg

Wind Observation Type -> Shore (windward)

Wind Fetch Option -> Open Water

Open-Water Wave Growth Equations Requestor

Open-Water Wave Growth Equation -> Shallow

Length of wind fetch	F	26	mi

Average Depth of Fetch Requestor

Average depth of fetch	d	13	ft

Output

Item	Symbol	Value	Units
Equivalent neutral wind speed	U_e	46.42	mph
Adjusted wind speed	U_a	67.92	mph
Wave height	H_{mo}	4.23	ft
Peak wave period	T_p	4.77	sec

Wave Growth: Shallow-water Fetch-limited

Example 2 - Shipboard Wind Observation - Open-Water Fetch - Deepwater Wave Equations

Input

Main Input Screen

Item	Symbol	Value	Units
Elevation of observed wind	Z_{obs}	60	ft
Observed wind speed	U_{obs}	30	knots
Air-sea temperature difference	ΔT	-5	deg C
Duration of observed wind	DUR	1	hr
Duration of final wind	DUR	3	hr
Latitude of wind observation	LAT	45	deg

Wind Observation Type -> Overwater (ship)

Wind Fetch Option -> Open Water

Open-Water Wave Growth Equations Requestor

Open-Water Wave Growth Equation -> Deep

Length of wind fetch	F	60	mi

Output

Item	Symbol	Value	Units
Equivalent neutral wind speed	U_e	27.71	knots
Adjusted wind speed	U_a	36.18	knots
Wave height	H_{mo}	4.74	ft
Peak wave period	T_p	4.65	sec

Wave Growth: Deepwater Duration-limited

Example 3 - Overwater Wind Observation - Deepwater Wave Equations - Restricted Fetch

Input

Main Input Screen

Item	Symbol	Value	Units
Elevation of observed wind	Z_{obs}	30	ft
Observed wind speed	U_{obs}	45	mph
Air-sea temperature difference	ΔT	-3	deg C
Duration of observed wind	*DUR*	5	hr
Duration of final wind	*DUR*	5	hr
Latitude of wind observation	*LAT*	47	deg

Wind Observation Type -> Overwater
Wind Fetch Option -> Restricted

Restricted Fetch Requestor

Wind Direction	α	125	deg

NOTE: α is measured clockwise from north.

Open-Water Wave Growth Equation -> Deep
Fetch Geometry Input Options -> Keyboard

Keyboard Data Entry Requestor

See Figure 1-1-11 for illustration showing wind direction and fetch geometry for example problem 3.

Radial Angle Increment	$\Delta\beta$	12	deg
Dir of 1st Radial Fetch	β_1	0	deg

NOTE: This direction angle is measured clockwise from north.

No of Radial Fetches	*Nfet*	14	

Fetch Geometry Data Entry Screen

Units	miles	Radial Number	Fetch Angle	Fetch Length
		1	0.0	3.7
		2	12.0	12.3
		3	24.0	13.4
		4	36.0	12.2
		5	48.0	13.2
		6	60.0	36.0
		7	72.0	35.6
		8	84.0	28.7
		9	96.0	26.8
		10	108.0	13.0
		11	120.0	10.4
		12	132.0	10.1
		13	144.0	6.4
		14	156.0	5.7

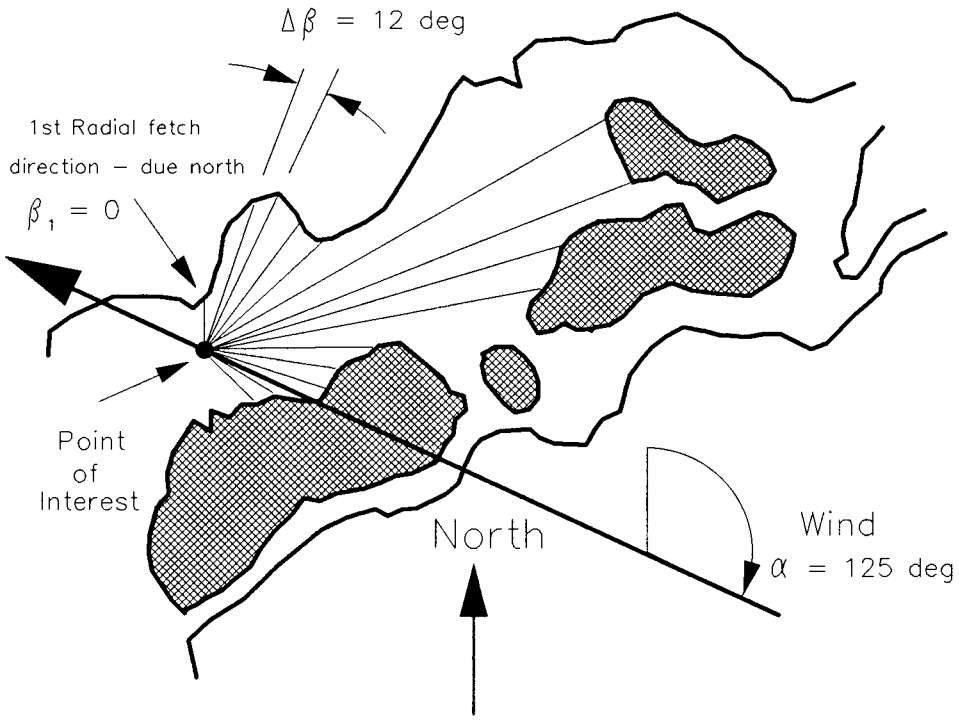

Figure 1-1-11. Restricted Fetch Geometry Illustration for Example 3

Output

Item	Symbol	Value	Units
Wind Fetch	F	26.61	mi
Wind Direction		125.00	deg
Equivalent neutral wind speed	U_e	44.00	mph
Adjusted wind speed	U_a	63.27	mph
Mean Wave Direction		93.00	deg
Wave height	H_{mo}	7.80	ft
Peak wave period	T_p	5.74	sec

Wave Growth: Deepwater Fetch-limited

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BETA-RAYLEIGH DISTRIBUTION

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BETA-RAYLEIGH DISTRIBUTION

DESCRIPTION

This application provides a statistical representation for a shallow-water wave height distribution. The Beta-Rayleigh distribution is expressed in familiar wave parameters: H_{mo} (energy-based wave height), T_p (peak spectral wave period), and d (water depth). After constructing the distribution, other statistically based wave height estimates such as H_{rms} , H_{mean} , $H_{1/10}$ can be easily computed. The Beta-Rayleigh distribution features a finite upper bound corresponding to the breaking wave height, and the expression collapses to the Rayleigh distribution in the deepwater limit. The methodology for this portion of the application is taken exclusively from Hughes and Borgman (1986).

INPUT

All data input for this application is done on one screen. The following list describes the necessary input parameters with their corresponding units and range of data recognized by this application:

Item	Symbol	Units	Data Range		
Wave height	H_{mo}	ft, m	0.1	to	60.0
Wave period	T_p	sec	2.0	to	30.0
Water depth	d	ft, m	0.1	to	3000.0

OUTPUT

Results from this application are displayed on one screen. In addition, there is an option (available in the Single Case Mode only) to send data to plot output file 1 (default name **PLOTDAT1.OUT**). This application also generates one screen plot. Each of these outputs is described below.

Screen Output

Results from this application are displayed on one screen. Those data include the original input values (in final units) and the following parameters:

Item	Symbol	English Units	Metric Units
Root-mean-squared (rms) wave height	H_{rms}	ft	m
Median wave height	H_{med}	ft	m

$H_{1/3}$	ft	m
$H_{1/10}$	ft	m
$H_{1/100}$	ft	m

NOTE: The Beta-Rayleigh distribution will revert to the Rayleigh distribution when $d/gT^2 \geq 0.01$. A message will appear at the bottom of the screen when this occurs.

Plot Output File 1

Plot output file 1 contains the Beta-Rayleigh or Rayleigh probability density function (pdf) and is written in the following format (see Table 1-2-1 in the example problem):

Field	Columns	Format	Data
1	8-10	I3	Point counter
2	14-23	F10.3	Wave height
3	33-42	F10.3	Beta-Rayleigh or Rayleigh probability density

Screen Plot

This application generates one plot which contains seven curves. The first curve (solid line) is the Beta-Rayleigh or Rayleigh prediction. The remaining curves (represented by individual symbols) are various wave-height probabilities (see Figure 1-2-1 in the example problem).

PROCEDURE

The bulleted items in the following lists indicate potentially optional instruction steps. Any application in ACES may be executed in a given session without quitting the program. The bulleted items provide instructions for accessing the application from various menu areas of the ACES program. Ignore bulleted instruction steps that are not applicable.

Single Case Mode

- Press F1 on the Main Menu to select Single Case Mode.
- Fill in the highlighted input fields on the General Specifications screen (or leave the default values). Press F1 when all data on this screen are correct.

- Press [F1] on the Functional Area Menu to select Wave Prediction.
- Press [F2] on the Wave Prediction Menu to select Beta-Rayleigh Distribution.

1. Fill in the highlighted input fields on the Beta-Rayleigh Distribution screen. Respond to any corrective instructions appearing at the bottom of the screen. Press [F1] when all data on this screen are correct.
2. All input and output data are displayed on the screen in the final system of units.
3. Press one of the following keys to select the appropriate action:

   [F1] Return to Step 1 for a new case.

   [F2] Plot the data.

   [F3] Send a summary of this case to the print file or device.

   [F4] Generate a file containing the plot data (Plot Output File 1).

   [F10] Exit this application and return to the Wave Prediction Menu.

Multiple Case Mode

- Press [F2] on the Main Menu to select Multi Case Mode.
- Fill in the highlighted input fields on the General Specifications screen (or leave the default values). Press [F1] when all data on this screen are correct.
- Press [F1] on the Functional Area Menu to select Wave Prediction.
- Press [F2] on the Wave Prediction Menu to select Beta-Rayleigh Distribution.

1. Move the cursor to select a variable on the Beta-Rayleigh Distribution screen (the selected variable name blinks). The current set of values for the variable is displayed on the right portion of the screen. When all variable sets are correct, go to Step 3.
2. Enter a set of values for the subject variable by following one of the input methods:

   a. Press [R] to select random method. Enter up to 20 values constituting a set for this variable (one in each field) on the right side of the screen. The set of 20 values originally displayed (first execution) in these fields contains the "delimiting" value, which "delimits" or "ends" the set. The "delimiting" value is *not* included as a member in the set unless it is the sole member.

b. Press [I] to select incremental method. Fill in the fields for minimum, maximum, and increment values for this variable on the right side of the screen. In this method, the members of the set include all values from the minimum to the maximum (both inclusive) at the specified increment.

The units field should also be specified for the variable regardless of input method. All members of a set of values for a subject variable are assigned the specified units. When all data are correct for the subject variable, press [F10] to return to Step 1. Errors are reported at the bottom of the screen and are corrected by pressing [F1] to allow respecification of the data for the subject variable.

3. Press [F1] to process the cases resulting from the combinations of the sets of data for all variables. The summary of each case will be sent to the print file or device. The screen will display the total number of cases to be processed as well as report progress. Errors are reported at the bottom of the screen and are corrected by pressing [F1] to allow respecification of variable sets.
4. Press one of the following keys to select the appropriate action:

   [F1] Return to Step 1 to specify new sets.

   [F10] Exit this application and return to the Wave Prediction Menu.

NOTE: Multiple Case Mode does not generate any plot output files or plots.

EXAMPLE PROBLEM

Input

All data input for this application is done on one screen. The values and corresponding units selected for this example problem are shown below.

Item	Symbol	Value	Units
Wave height	H_{mo}	5.00	ft
Wave period	T_p	6.30	sec
Water depth	d	10.20	ft

Output

Results from this application are displayed on one screen and, if requested, written to plot output file 1 (default name **PLOTDAT1.OUT**). In addition, one plot is generated. Each of these outputs for the example problem is presented below.

Screen Output

Results from this application are displayed on one screen. Those data include the original input values and the following parameters:

Item	Symbol	Value	Units
Wave heights	H_{rms}	3.72	ft
	H_{med}	3.26	ft
	$H_{1/3}$	5.18	ft
	$H_{1/10}$	6.55	ft
	$H_{1/100}$	7.48	ft

Plot Output File 1

Table 1-2-1 below is a partial listing of plot output file 1 (default name **PLOTDAT1.OUT**) generated by this application for the example problem.

Table 1-2-1
Partial Listing of Plot Output File 1 for Example Problem

Counter	Wave height	Probability density
1	0.00000	0.00000
2	0.10200	0.03707
3	0.20400	0.07630
4	0.30600	0.11618
5	0.40800	0.15624
6	0.51000	0.19621
7	0.61200	0.23586
8	0.71400	0.27499
9	0.81600	0.31342
10	0.91800	0.35100
11	1.02000	0.38756
12	1.12200	0.42297
13	1.22400	0.45710
⇓	⇓	⇓

(Table 1-2-1 Continued on the Next Page)

(Table 1-2-1 Concluded)

89	8.97600	0.00085
90	9.07800	0.00054
91	9.18000	0.00033
92	9.28200	0.00019
93	9.38400	0.00010
94	9.48600	0.00005
95	9.58800	0.00002
96	9.69000	0.00001
97	9.79200	0.00000
98	9.89400	0.00000
99	9.99600	0.00000
100	10.09800	0.00000
101	10.20000	0.00000

Screen Plot

This application generates one plot. The plot may be accessed by selecting the **Plot Data** option (F2) from the **Options** menu on the data output screen. The plot generated is shown in Figure 1-2-1 below. The first curve (solid line) is the Beta-Rayleigh or Rayleigh prediction. The remaining curves (represented by single symbols) are various wave-height probabilities. (This figure has been slightly altered from its actual appearance on screen to allow the wave height probability symbols to be clearly visible.)

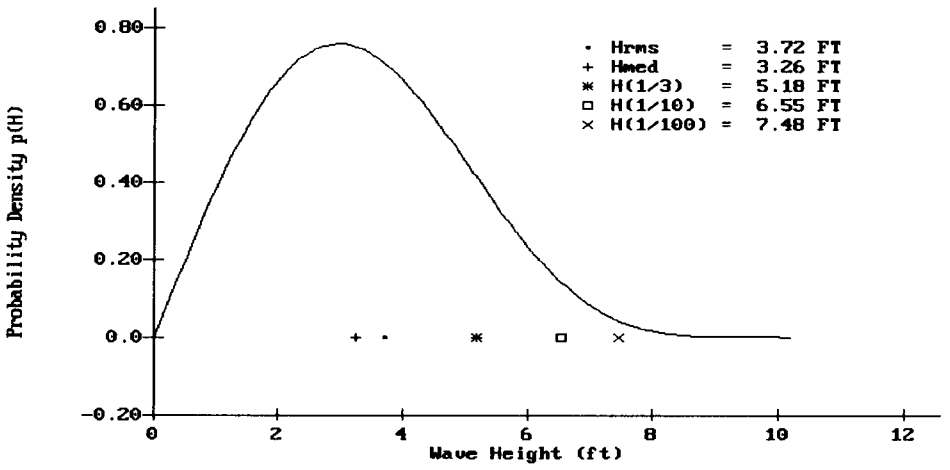

Figure 1-2-1. Beta-Rayleigh Predictions for Example Problem

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EXTREMAL SIGNIFICANT WAVE HEIGHT ANALYSIS

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EXTREMAL SIGNIFICANT WAVE HEIGHT ANALYSIS

DESCRIPTION

This application provides significant wave height estimates for various return periods. Confidence intervals are also provided. The approach developed by Goda (1988) is used to fit five candidate probability distributions to an input array of extreme significant wave heights. Candidate distribution functions are Fisher-Tippett Type I and Weibull with exponents ranging from 0.75 to 2.0. Goodness-of-fit information is provided for identifying the distributions which best match the input data.

INPUT

The input requirements of this application consist of the following information:

- Estimated total number of events (N_T) from the population during the length of record.
- Length of the record in years (K).
- Water depth to check for depth-limited wave heights.
- Significant wave heights (H_s) from long-term data source of measurements, hindcasts, or observations.
- Confidence level for calculating a confidence interval.

Data input to this application is accomplished through numerous input screens or through data saved in an external file. Detailed lists of the screens and input parameters are presented in the *Procedure* section of this document.

OUTPUT

Results from this application are displayed on three screens and written to plot output file 1 (default name **PLOTDAT1.OUT**). This application also generates five plots. The three output screens and five plots are described in the *Procedure* section of this document. The content of the plot output file is described below (refer to the **Example Problem** section for a paradigm). Equation numbers given below and referenced in the plot output file refer to equations in Section 1-3 of the ACES *Technical Reference*, titled *Extremal Significant Wave Height Analysis*.

Plot Output File 1

This file contains, for each of the five distributions, tabular summaries of:

- Correlation and the sum of the squares of the residuals.
- Estimates of the scale and location parameters from linear regression analysis.
- The probability assigned to each significant wave height (Equation *3*).
- A reduced variate (Equation *5*).
- An ordered variate (Equation *4*).
- Difference between the significant wave height and the ordered variate.
- Expected extreme wave height for a given return period (Equation *6*).
- Absolute magnitude of the standard deviation of significant wave height (Equation *10*).

PROCEDURE

This application provides only a Single Case Mode. The Multiple Case Mode is not available. The Single Case Mode requires interaction with the application and provides two options of interactive participation. The first option allows entering new data sets, and the second option allows the editing of existing data files.

Single Case Mode

- Press F1 on the Main Menu to select Single Case Mode.
- Fill in the highlighted input fields on the General Specifications screen (or leave the default values). Press F1 when all data on this screen are correct.
- Press F1 on the Functional Area Menu to select Wave Prediction.
- Press F3 on the Wave Prediction Menu to select Extremal Significant Wave Height Analysis.

Data Entry Options Menu

This menu provides two options of interactive participation with the application.

F1 Initial Case Data Entry

Use this option to enter an initial (new) set of data. These data will be written to the *Trace Output* file (default name **TRACE.OUT**) and become available for subsequent editing and use.

(Alt) (F1) Edit Case in External File: EXTREMAL.IN

Use this option to access and modify data saved in an external file. This external data file is created by saving (or copying) a *trace file* from a previous execution of this application. The format and contents of the *trace file* for this application match exactly the requirements of this input file. The default input filename is **EXTREMAL.IN**, but other filenames (including pathname) are acceptable. After entering the filename, press (ENTER) to accept this file. *For more information on files, see the section of this manual entitled, "General Instructions and Information."*

Activity Menu

The Activity Menu is a point from which all options for Single Case data entry, modification, and execution are accessible. The options are:

(F1) Begin Computations.

(F2) Significant Wave Height Entry.

(F3) Confidence Interval Limits Entry.

(F4) Review Output Screens.

(F5) Plot Output Data.

(F10) Exit Menu.

Each option and the required data are described below.

(F1) Begin Computations

Use this option only after all data have been entered.

(F2) Significant Wave Height Data Entry

This screen provides for input of general parameters required to run the application. Values for all parameters listed are required.

Item	Units	Data Range		
Units	ft,m			
N_T		0	to	10000.0
Period (yr) K	years	0	to	999.9
Water Depth	ft,m	0	to	1000.0
Significant Wave Height for Each Storm	ft,m	0	to	100.0

NOTE: There is space provided on this screen to enter a title or description (optional) to identify where the significant wave data is coming from. This title will appear in the plot output file for reference.

NOTE: If there are more than 50 significant heights to be entered, press [F1] to access subsequent screens for entering the remaining values. Each screen will allow input of 50 values. The application will allow for a maximum of 200 values to be entered. After completing data entry on this screen, press [F10] to return to the Activity Menu.

[F3] Confidence Interval Limits Entry

This screen provides for selecting a particular *Confidence Interval.* Use the arrow keys to move the blinking cursor to the desired *Confidence Interval* and press [F1] to select it. The choices are:

80% Confidence Interval
85% Confidence Interval
90% Confidence Interval
95% Confidence Interval
99% Confidence Interval

[F4] Review Output Screens

This option allows for viewing the output of this application, which appears on three screens. The three screens are described below:

- The first screen is a table of extremal significant wave heights for different return periods for the five distribution functions. Also included in the table are two statistics (correlation and sum of the squares of the residuals) to assist in selecting the best fit distribution function.
- The second screen is a table of confidence intervals for different return periods for the five distribution functions.
- The third screen is a table of percent chance that the significant wave height will equal or exceed the return-period significant height during the period of concern.

F5 Plot Output Data

This application generates five plots. The plots may be accessed from the **EXTREMAL WAVE HEIGHT PLOT MENU**, which appears when the **Plot Output Data** option is requested. To access a plot, move the cursor (using the arrow keys) to the desired plot and press F1. (Appendix C describes options to customize plots.) Available plots are:

- Fisher-Tippett (FT-I) (see Figure 1-3-1)
- Weibull Dist (k=0.75) (see Figure 1-3-2)
- Weibull Dist (k=1.00) (see Figure 1-3-3)
- Weibull Dist (k=1.40) (see Figure 1-3-4)
- Weibull Dist (k=2.00) (see Figure 1-3-5)
- ALL PLOTS

  NOTE: This option will make all the plots available for viewing. Use the **NEXT** option of the graphics package (Appendix C) to view each plot successively.
- EXIT MENU

Each plot contains four curves:

- Expected extreme wave heights for given return periods.
- Candidate probability distribution.
- Upper confidence limit.
- Lower confidence limit.

EXAMPLE PROBLEM

Input

The input for this example problem has been saved in an example file called **EXTDELFT.IN**. Refer to the section titled *Procedure* for instructions to invoke and run this data set.

(F2) *Significant Wave Height Data Entry*

Item	Value
Units	meters
N_T	20
Period (yr) K	20
Water Depth	500
Significant Wave Height for Each Storm	
1	9.32
2	8.11
3	7.19
4	7.06
5	6.37
6	6.15
7	6.03
8	5.72
9	4.92
10	4.90
11	4.78
12	4.67
13	4.64
14	4.19
15	3.06

(F3) *Confidence Interval Limits Entry*

90% Confidence Interval

Output

Results from this application are displayed on three screens and written to plot output file 1 (default name **PLOTDAT1.OUT**). In addition five plots are generated. Each of these outputs is described below.

Screen Output

The first screen is a table of extremal significant wave heights for different return periods for the five distribution functions. Also included in the table are two statistics (correlation and sum of the squares of the residuals) to assist in selecting the best fit distribution function.

First Screen					
N = 15 NU = 0.75 NT = 20 K = 20 yr	FT-I	Weibull Distribution			
LAMBDA = 1.00		k=0.75	k=1.00	k=1.40	k=2.00
Correlation Sum Square of Residuals	0.9813 0.1601	0.9414 0.7816	0.9674 0.3568	0.9818 0.2201	0.9866 0.1034
Return Period (Yr)	H_s (ft)	H_s (ft)	H_s (ft)	H_s (ft)	H_s (ft)
2	15.94	15.96	15.79	15.77	15.86
5	21.50	20.18	20.91	21.56	22.02
10	25.18	24.00	24.79	25.29	25.53
25	29.84	29.66	29.91	29.76	29.44
50	33.29	34.33	33.79	32.90	32.03
100	36.72	39.29	37.66	35.89	34.40

The second screen is a table of confidence intervals for different return periods for the five distribution functions.

Second Screen					
90% Confidence Interval (Lower Bound - Upper Bound) UNITS (ft)					
Return Period	FT-I	Weibull Distribution			
		k=0.75	k=1.00	k=1.40	k=2.00
5	17.7 - 25.3	15.1 - 25.3	16.4 - 25.4	17.2 - 25.9	17.8 - 26.2
10	19.7 - 30.7	15.8 - 32.2	17.9 - 31.7	19.2 - 31.3	20.1 - 31.0
25	22.0 - 37.7	16.5 - 42.8	19.7 - 40.1	21.6 - 38.0	22.5 - 36.4
50	23.6 - 43.0	17.1 - 51.5	21.1 - 46.5	23.2 - 42.6	24.1 - 40.0
100	25.2 - 48.2	17.8 - 60.8	22.4 - 52.9	24.7 - 47.1	25.5 - 43.3

The third screen is a table of percent chance that the significant wave height will equal or exceed the return-period significant height during the period of concern.

Third Screen						
Percent Chance for Significant Height Equaling or Exceeding Return Period H_s						
Return Period	Period of Concern (Yr)					
	2	5	10	25	50	100
2	75	97	100	100	100	100
5	36	67	89	100	100	100
10	19	41	65	93	99	100
25	8	18	34	64	87	98
50	4	10	18	40	64	87
100	2	5	10	22	39	63

Plot Output File 1

This file contains, for each of the five distributions, tabular summaries of:

- Correlation and the sum of the squares of the residuals.
- Estimates of the scale and location parameters from linear regression analysis.
- The probability assigned to each significant wave height (Equation *3*).
- A reduced variate (Equation *5*).
- An ordered variate (Equation *4*).
- Difference between the significant wave height and the ordered variate.
- Expected extreme wave height for a given return period (Equation *6*).
- Absolute magnitude of the standard deviation of significant wave height (Equation *10*).

Equation numbers refer to equations in Section 1-3 of the ACES *Technical Reference*, titled *Extremal Significant Wave Height Analysis*.

Table 1-3-1 is a complete listing of plot output file 1 (default name **PLOTDAT1.OUT**).

Table 1-3-1
Listing of Plot Output File 1 for Example Problem

EXTREMAL SIGNIFICANT WAVE HEIGHT ANALYSIS
DELFT Data

N = 15 STORMS

NT = 20 STORMS

NU = 0.75

K = 20.00 YEARS

LAMBDA = 1.00 STORMS PER YEAR

MEAN OF SAMPLE DATA = 19.053 FEET

STANDARD DEVIATION OF SAMPLE = 5.341 FEET

(Table 1-3-1 Continued on the Next Page)

(Table 1-3-1 Continued)

FISHER-TIPPETT TYPE I (FT-I) DISTRIBUTION

F(Hs) = EXP(-EXP(-(Hs-B)/A)) - Equation *1*

A = 4.910 FEET

B = 14.136 FEET

CORRELATION = 0.9813

SUM SQUARE OF RESIDUALS = 0.1601 FEET

RANK	Hsm (Ft)	F(Hs<=Hsm) Eq. *3*	Ym Eq. *5*	A*Ym+B (Ft) Eq. *4*	Hsm-(A*Ym+B) (Ft)
1	30.58	0.9722	3.567	31.6513	-1.0739
2	26.61	0.9225	2.517	26.4935	0.1141
3	23.59	0.8728	1.994	23.9281	-0.3388
4	23.16	0.8231	1.636	22.1690	0.9937
5	20.90	0.7734	1.359	20.8064	0.0926
6	20.18	0.7237	1.129	19.6777	0.4995
7	19.78	0.6740	0.930	18.7014	1.0821
8	18.77	0.6243	0.752	17.8303	0.9361
9	16.14	0.5746	0.590	17.0340	-0.8922
10	16.08	0.5249	0.439	16.2914	-0.2153
11	15.68	0.4751	0.296	15.5868	0.0956
12	15.32	0.4254	0.157	14.9071	0.4145
13	15.22	0.3757	0.021	14.2407	0.9824
14	13.75	0.3260	-0.114	13.5761	0.1706
15	10.04	0.2763	-0.252	12.9003	-2.8609

RETURN PERIOD TABLE with 90% CONFIDENCE INTERVAL

RETURN PERIOD (Yr)	Hs (Ft) Eq. *6*	SIGR (Ft) Eq. *10*	Hs-1.28*SIGR (Ft)	Hs+1.28*SIGR (Ft)
2.00	15.94	1.38	13.66	18.21
5.00	21.50	2.27	17.75	25.25
10.00	25.18	3.32	19.71	30.66
25.00	29.84	4.76	21.99	37.69
50.00	33.29	5.86	23.63	42.96
100.00	36.72	6.96	25.24	48.20

(Table 1-3-1 Continued on the Next Page)

(Table 1-3-1 Continued)

WEIBULL DISTRIBUTION k = 0.75

F(Hs) = 1-EXP(-((Hs-B)/A)**k) Equation *2*

A = 3.310 FEET

B = 13.933 FEET

CORRELATION = 0.9414

SUM SQUARE OF RESIDUALS = 0.7816 FEET

RANK	Hsm (Ft)	F(Hs<=Hsm) Eq. *3*	Ym Eq. *5*	A*Ym+B (Ft) Eq. *4*	Hsm-(A*Ym+B) (Ft)
1	30.58	0.9761	5.796	33.1177	-2.5403
2	26.61	0.9273	3.614	25.8942	0.7134
3	23.59	0.8784	2.701	22.8739	0.7153
4	23.16	0.8296	2.140	21.0156	2.1471
5	20.90	0.7807	1.744	19.7032	1.1957
6	20.18	0.7318	1.442	18.7065	1.4707
7	19.78	0.6830	1.203	17.9146	1.8688
8	18.77	0.6341	1.007	17.2663	1.5001
9	16.14	0.5852	0.843	16.7240	-0.5823
10	16.08	0.5364	0.704	16.2632	-0.1871
11	15.68	0.4875	0.585	15.8672	-0.1848
12	15.32	0.4387	0.481	15.5241	-0.2025
13	15.22	0.3898	0.390	15.2250	-0.0019
14	13.75	0.3409	0.311	14.9635	-1.2168
15	10.04	0.2921	0.242	14.7347	-4.6954

RETURN PERIOD TABLE with 90% CONFIDENCE INTERVAL

RETURN PERIOD (Yr)	Hs (Ft) Eq. *6*	SIGR (Ft) Eq. *10*	Hs-1.28*SIGR (Ft)	Hs+1.28*SIGR (Ft)
2.00	15.96	1.47	13.54	18.38
5.00	20.18	3.08	15.09	25.26
10.00	24.00	4.99	15.76	32.23
25.00	29.66	7.95	16.54	42.78
50.00	34.33	10.42	17.14	51.53
100.00	39.29	13.05	17.75	60.83

(Table 1-3-1 Continued on the Next Page)

(Table 1-3-1 Continued)

WEIBULL DISTRIBUTION k = 1.00

F(Hs) = 1-EXP(-((Hs-B)/A)**k)

A = 5.592 FEET

B = 11.913 FEET

CORRELATION = 0.9674

SUM SQUARE OF RESIDUALS = 0.3568 FEET

RANK	Hsm (Ft)	F(Hs<=Hsm) Eq. *3*	Ym Eq. *5*	A*Ym+B (Ft) Eq. *4*	Hsm-(A*Ym+B) (Ft)
1	30.58	0.9741	3.652	32.3332	-1.7558
2	26.61	0.9251	2.592	26.4053	0.2023
3	23.59	0.8762	2.089	23.5930	-0.0038
4	23.16	0.8272	1.756	21.7306	1.4321
5	20.90	0.7783	1.506	20.3359	0.5630
6	20.18	0.7293	1.307	19.2206	0.9566
7	19.78	0.6804	1.141	18.2912	1.4923
8	18.77	0.6314	0.998	17.4944	1.2720
9	16.14	0.5825	0.873	16.7972	-0.6555
10	16.08	0.5335	0.763	16.1773	-0.1012
11	15.68	0.4846	0.663	15.6194	0.0630
12	15.32	0.4356	0.572	15.1121	0.2094
13	15.22	0.3867	0.489	14.6470	0.5761
14	13.75	0.3377	0.412	14.2177	-0.4710
15	10.04	0.2888	0.341	13.8190	-3.7796

RETURN PERIOD TABLE with 90% CONFIDENCE INTERVAL

RETURN PERIOD (Yr)	Hs (Ft) Eq. *6*	SIGR (Ft) Eq. *10*	Hs-1.28*SIGR (Ft)	Hs+1.28*SIGR (Ft)
2.00	15.79	1.41	13.46	18.12
5.00	20.91	2.75	16.38	25.45
10.00	24.79	4.18	17.89	31.68
25.00	29.91	6.17	19.73	40.10
50.00	33.79	7.71	21.07	46.51
100.00	37.66	9.25	22.39	52.93

(Table 1-3-1 Continued on the Next Page)

(Table 1-3-1 Continued)

WEIBULL DISTRIBUTION k = 1.40

F(Hs) = 1-EXP(-((Hs-B)/A)**k)

A = 9.115 FEET

B = 8.756 FEET

CORRELATION = 0.9818

SUM SQUARE OF RESIDUALS = 0.2201 FEET

RANK	Hsm (Ft)	F(Hs<=Hsm) Eq. *3*	Ym Eq. *5*	A*Ym+B (Ft) Eq. *4*	Hsm-(A*Ym+B) (Ft)
1	30.58	0.9720	2.484	31.3960	-0.8185
2	26.61	0.9229	1.959	26.6092	-0.0016
3	23.59	0.8739	1.682	24.0859	-0.4967
4	23.16	0.8249	1.487	22.3067	0.8561
5	20.90	0.7758	1.333	20.9058	-0.0068
6	20.18	0.7268	1.204	19.7347	0.4424
7	19.78	0.6778	1.093	18.7179	1.0655
8	18.77	0.6287	0.993	17.8111	0.9553
9	16.14	0.5797	0.903	16.9861	-0.8444
10	16.08	0.5307	0.819	16.2233	-0.1472
11	15.68	0.4816	0.741	15.5087	0.1737
12	15.32	0.4326	0.667	14.8314	0.4901
13	15.22	0.3836	0.595	14.1826	1.0405
14	13.75	0.3345	0.526	13.5545	0.1922
15	10.04	0.2855	0.459	12.9400	-2.9007

RETURN PERIOD TABLE with 90% CONFIDENCE INTERVAL

RETURN PERIOD (Yr)	Hs (Ft) Eq. *6*	SIGR (Ft) Eq. *10*	Hs-1.28*SIGR (Ft)	Hs+1.28*SIGR (Ft)
2.00	15.77	1.45	13.37	18.17
5.00	21.56	2.63	17.22	25.91
10.00	25.29	3.66	19.25	31.34
25.00	29.76	4.97	21.56	37.96
50.00	32.90	5.91	23.16	42.65
100.00	35.89	6.80	24.66	47.12

(Table 1-3-1 Continued on the Next Page)

(Table 1-3-1 Concluded)

WEIBULL DISTRIBUTION k = 2.00

F(Hs) = 1-EXP(-((Hs-B)/A)**k)

A = 14.115 FEET

B = 4.112 FEET

CORRELATION = 0.9866

SUM SQUARE OF RESIDUALS = 0.1034 FEET

RANK	Hsm (Ft)	F(Hs<=Hsm) Eq. *3*	Ym Eq. *5*	A*Ym+B (Ft) Eq. *4*	Hsm-(A*Ym+B) (Ft)
1	30.58	0.9701	1.873	30.5547	0.0228
2	26.61	0.9210	1.593	26.5991	0.0085
3	23.59	0.8719	1.433	24.3450	-0.7557
4	23.16	0.8228	1.315	22.6789	0.4838
5	20.90	0.7737	1.219	21.3167	-0.4178
6	20.18	0.7245	1.135	20.1395	0.0376
7	19.78	0.6754	1.061	19.0852	0.6983
8	18.77	0.6263	0.992	18.1165	0.6500
9	16.14	0.5772	0.928	17.2087	-1.0670
10	16.08	0.5281	0.867	16.3443	-0.2682
11	15.68	0.4790	0.807	15.5096	0.1728
12	15.32	0.4299	0.750	14.6931	0.6285
13	15.22	0.3808	0.692	13.8842	1.3389
14	13.75	0.3317	0.635	13.0725	0.6742
15	10.04	0.2826	0.576	12.2461	-2.2067

RETURN PERIOD TABLE with 90% CONFIDENCE INTERVAL

RETURN PERIOD (Yr)	Hs (Ft) Eq. *6*	SIGR (Ft) Eq. *10*	Hs-1.28*SIGR (Ft)	Hs+1.28*SIGR (Ft)
2.00	15.86	1.51	13.37	18.36
5.00	22.02	2.55	17.81	26.23
10.00	25.53	3.32	20.06	31.00
25.00	29.44	4.22	22.48	36.39
50.00	32.03	4.83	24.06	40.00
100.00	34.40	5.40	25.50	43.30

Screen Plots

This application generates five plots. The plots may be accessed from the **EXTREMAL WAVE HEIGHT PLOT MENU**, which appears when the **Plot Output Data** option (F5) from the **Activity Menu** is requested. To access a plot, move the cursor (using the arrow keys) to the desired plot and press F1. (Appendix C describes options to customize plots.) The plots generated are shown in Figures 1-3-1 through 1-3-5.

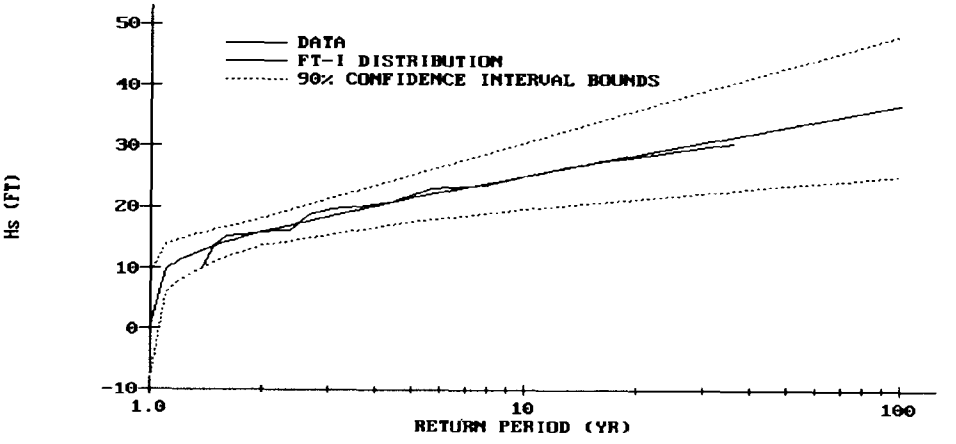

Figure 1-3-1. Fisher-Tippett Distribution and Expected Extreme Wave Heights with Confidence Limits

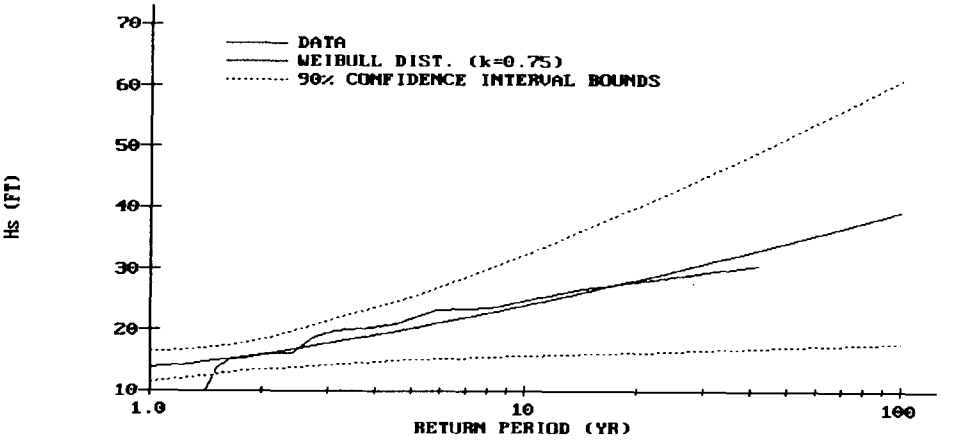

Figure 1-3-2. Weibull Distribution (k=0.75) and Expected Extreme Wave Heights with Confidence Limits

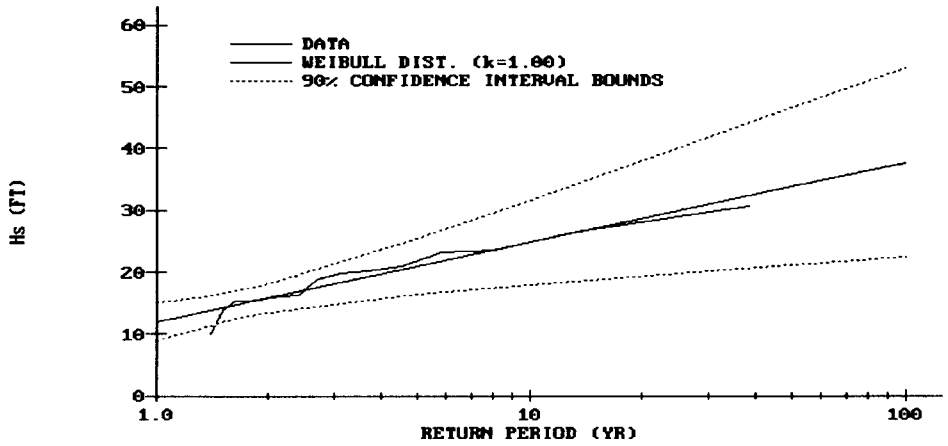

Figure 1-3-3. Weibull Distribution (k=1.00) and Expected Extreme Wave Heights with Confidence Limits

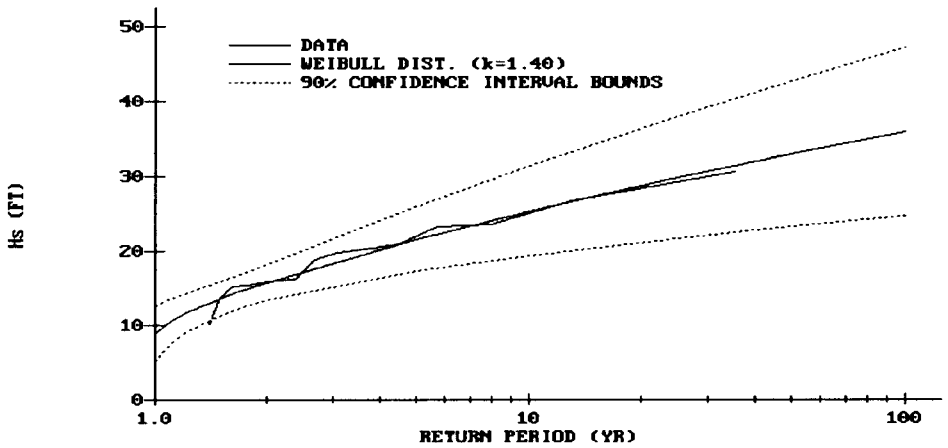

Figure 1-3-4. Weibull Distribution (k=1.40) and Expected Extreme Wave Heights with Confidence Limits

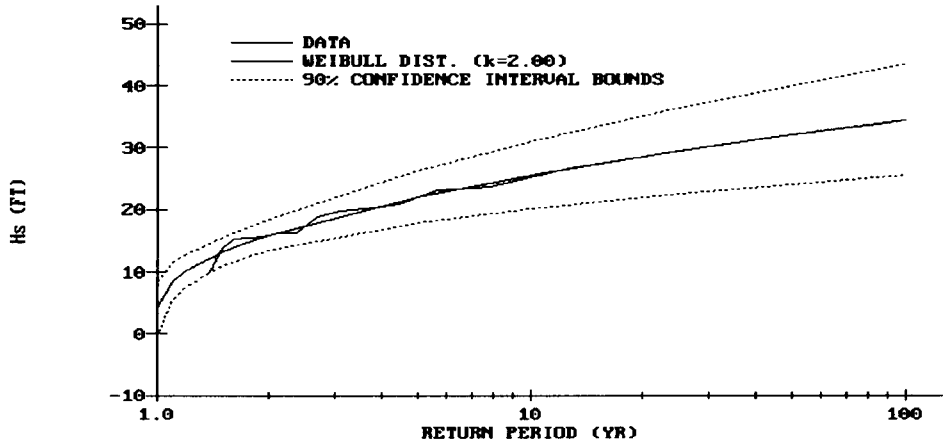

Figure 1-3-5. Weibull Distribution (k=2.00) and Expected Extreme Wave Heights with Confidence Limits

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CONSTITUENT TIDE RECORD GENERATION

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CONSTITUENT TIDE RECORD GENERATION

DESCRIPTION

This ACES application predicts a tide elevation record at a specific time and locale using known amplitudes and epochs for individual harmonic constituents.

INPUT

The input requirements of this application consist of two general types of information.

- General temporal data.
- Constituent data for the particular desired location.

Data input to this application is accomplished by interaction with several input screens or by reading data from an external file. Detailed lists of the screens and input parameters are presented in the *Procedure* section of this document.

OUTPUT

This application generates one plot (see section titled **Plot Output Data**). In addition, there is an option to send data to plot output file 1 (default name **PLOTDAT1.OUT**). The contents and organization of output data in the plot output file are summarized below.

Plot Output File 1

This file contains the tide elevation at specific times. Plot output file 1 is written in the following format:

Field	Columns	Format	Data
1	1-8	F8.2	Time in hours from beginning of simulation
2	19-26	F8.2	Elevation of the tide

PROCEDURE

This application provides only a Single Case Mode. The Multiple Case Mode is not available. Single Case Mode requires interaction with the application and provides two options of interactive participation. The first option allows entering new data sets, and the second option allows editing of data sets read from an external file.

Single Case Mode

The bulleted items in the following lists indicate potentially optional instruction steps. Any application in ACES may be executed in a given session without quitting the program. The bulleted items provide instructions for accessing the application from various menu areas of the ACES program. Ignore bulleted instruction steps that are not applicable.

- Press [F1] on the Main Menu to select Single Case Mode.
- Fill in the highlighted input fields on the General Specifications screen (or leave the default values). *For information on input requirements on the General Specifications screen, please refer to the section of the User's Guide entitled "General Instructions and Information."* Press [F1] when all data on this screen are correct.
- Press [F1] on the Functional Area Menu to select Wave Prediction.
- Press [F4] on the Wave Prediction Menu to select Constituent Tide Record Generation.

Data Entry Options Menu

This menu provides two options of interactive participation with the application:

Initial Case Data Entry

Use [F1] option to enter an initial (new) set of data. These data will be written to the *Trace Output* file and become available for subsequent editing and use.

Edit Case in an External File

Use [Alt] [F1] option to access and modify data from an external file. This external data file is created by saving (or copying) a trace file from a previous execution of this application. The format and contents of the trace file for this application match exactly the requirements of this input file. The default input file name is **TIDES.IN**, but other filenames (including pathname) are acceptable. After entering the filename, press [ENTER] to accept this file. *For more information on files, see the section of this manual entitled "General Instructions and Information."*

Activity Menu

The Activity Menu is a pivotal point from which all options for Single Case data entry, modification, and execution are accessible. The options are:

[F1]	Generate the Tide Elevation Record.
[F2]	General Time & Output Specifications.
[F3]	Constituent Data Entry.
[F4]	Write Tide Record to *current plot output filename.*
[F5]	Plot the Tide Record.
[F10]	Exit Menu.

Each option and the required data are described below.

[F1] Generate the Tide Elevation Record

Use this option only after all data have been entered.

(F2) General Time & Output Specifications

This screen provides for input of general parameters required to run the application. Values for all parameters listed except *Description* are required.

Item	Units	Data Range		
Simulation Start Time:				
Year		1900	to	2050
Month		1	to	12
Day		1	to	31
Hour		0	to	24
Length of Record	hr	0	to	744
Output Time Interval	hr,min	1	to	60
Mean Water Level Height above Datum	ft,m	-100	to	100
Description	alphanumeric			

CAUTION: The number of points used in calculating the tide record is determined by dividing the *Length of Record* by the *Output Time Interval*. A maximum of 1,500 points are allowed by this application. If this maximum is exceeded, an error message will be displayed on screen.

NOTE: When all required data have been entered on this screen, press (F10) to return to the Activity Menu.

(F3) Constituent Data Entry

This series of screens provides for input of constituent data (amplitude and epoch) for any of 37 constituents. The major tidal constituents accepted by this application are listed in Table A-5 in Appendix A.

Item	Units	Data Range		
Gage Longitude	deg West	-180.0	to	180.00
Amplitude Units	ft,m			
Amplitude of Individual Constituent$_n$	ft,m	0.0	to	999.99

Epoch of Individual Constituent$_n$	deg	0.0	to	360.00

NOTE: The symbols of 37 common harmonic constituents (see Table A-5 in Appendix A) are displayed on a series of screens. Place the values of amplitude and epoch by the appropriate desired constituent symbol.

Press [F1] to continue additional *constituent* input on subsequent screens. When finished entering all data, press [F10] to return to the Activity Menu.

The number of constituents needed to describe the astronomical tide varies with the location. More terms are needed where the tide must travel a great distance over shallow water than when the tide station is near the open sea. Additional terms may be needed to obtain an adequate representation when the tidal range is large rather than small (Harris, 1981). In the United States, 37 standards constituents (Table A-5, Appendix A) are found to be adequate for most tide stations (Schureman, 1971). These harmonic constituents are available for many US locations from the National Ocean Survey.

[F4] Write Tide Record to Plot Output File 1

This option generates a plot output file (default name **PLOTDAT1.OUT**) containing tide elevations at specific times. Plot output file 1 is written in the following format (see Table 1-4-1 in the Example Problem):

Field	Columns	Format	Data
1	1-8	F8.2	Time in hours from beginning of simulation
2	19-26	F8.2	Elevation of the tide

[F5] Plot the Tide Record

This application generates one plot (see Figure 1-4-1 in the Example Problem) consisting of the tide elevation against time for the *Length of Simulation* specified on the **General Time & Output Specifications** screen..

EXAMPLE PROBLEM

Input

(F2) General Time & Output Specifications Data Entry

Item	Value	Units
Simulation Start Time:		
Year	1989	
Month	1	
Day	10	
Hour	10.00	
Length of Record	120.00	hr
Output Time Interval	15.00	min
Mean Water Height above Datum	1.79	ft
Description	Buzzards Bay Entrance, MA (Datum MLLW)	

(F3) Constituent Data Entry

Item	Value	Units
Gage Longitude	70.62	deg West
Amplitude Units		ft

Constituents	Amplitude	Epoch
M_2	1.621	269.90
S_2	0.303	283.60
N_2	0.447	245.10
K_1	0.262	114.00
M_4	0.266	136.70
O_1	0.221	123.90
M_6	0.070	241.90
MK_3	0.045	138.00
MN_4	0.113	82.20
NU_2	0.077	262.20
MU_2	0.070	225.00
$2N_2$	0.071	225.70
$LAMBDA_2$	0.011	276.30
S_1	0.038	55.30
M_1	0.016	119.00
J_1	0.017	109.00
SSA	0.037	44.60

(Constituent Data Entry continued on the next page)

(Constituent Data Entry concluded)

SA	0.112	151.60
Q_1	0.045	112.60
T_2	0.018	283.60
P_1	0.091	123.80
L_2	0.045	294.70
$2MK_3$	0.039	159.00
K_2	0.091	274.20
MS_4	0.076	231.00

NOTE: All other harmonic constituents are 0.0 for this example.

Output

Screen Plot

Figure 1-4-1 is the one plot generated for this Example Problem. The plot may be accessed from the **Activity** menu screen by pressing F5.

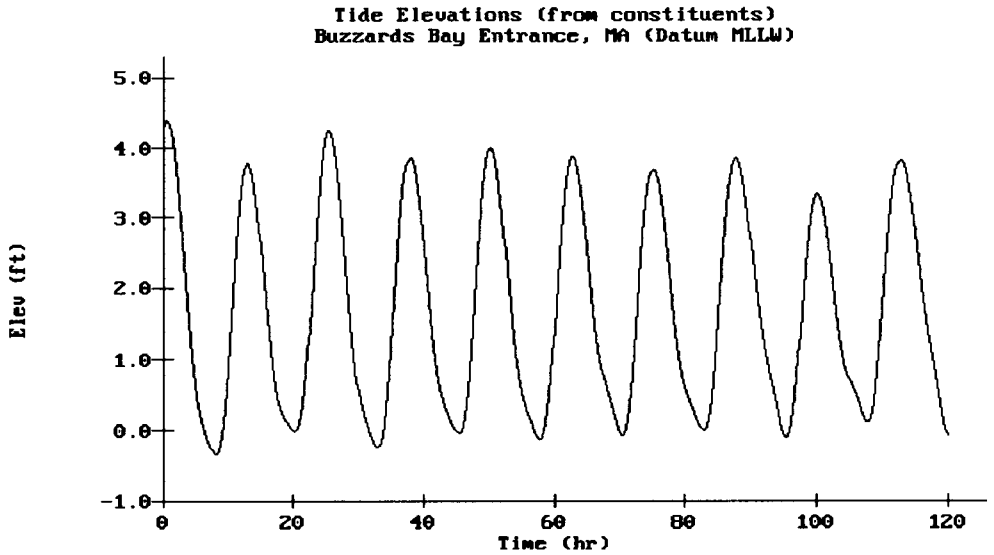

Figure 1-4-1. Tidal Elevation Curve for the Example Problem

Plot Output File 1

In addition to the screen plot, the data can be sent to plot output file 1 (default name **PLOTDAT1.OUT**) by pressing F4. This file contains tide elevations at specific times. Table 1-4-1 is a listing of the plot output file 1 for the Example Problem.

Table 1-4-1
Listing of Plot Output FIle 1 for
Example Problem

CONSTITUENT TIDE
ELEVATION RECORD
Buzzards Bay Entrance, MA
(Datum MLLW)

TIME (hrs)	ELEVATION (feet)
0.00	4.26
0.25	4.35
0.50	4.39
0.75	4.38
1.00	4.32
⇓	⇓
118.50	0.65
118.75	0.52
119.00	0.38
119.25	0.25
119.50	0.12
119.75	0.01
120.00	-0.08

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