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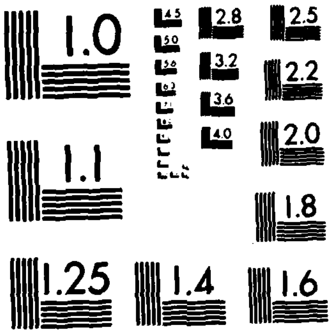

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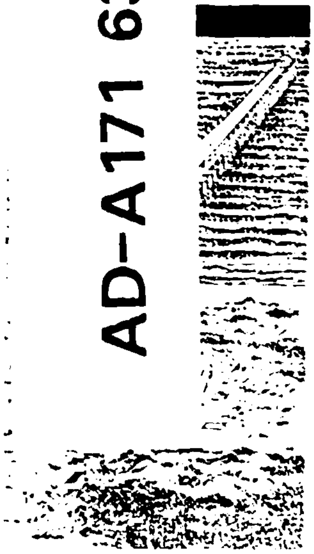

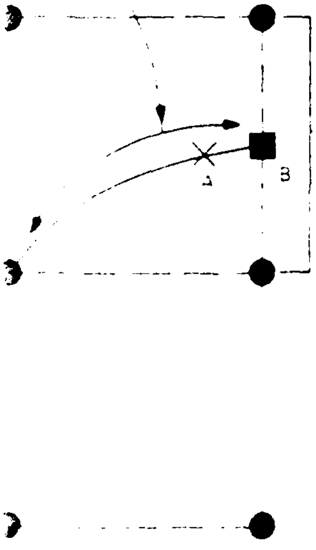

INSTRUCTION REPORT CERC-86-2

# A USER'S GUIDE TO SHALWV: NUMERICAL MODEL FOR SIMULATION OF SHALLOW-WATER WAVE GROWTH, PROPAGATION, AND DECAY

by

Steven A. Hughes, Robert E. Jensen

Coastal Engineering Research Center

DEPARTMENT OF THE ARMY
Waterways Experiment Station, Corps of Engineers
PO Box 631, Vicksburg Mississippi 39180-0631

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SHALWV is a numerical model that simulates shallow-water wave growth, propagation, and decay in a directional spectrum over an arbitrary bathymetry. It is a time-dependent model requiring a primary input of the wind speed and wind direction at each grid point. Part I of this report contains an overview of SHALWV consisting of the model description, the theoretical background, and the model applications and limitations. Part II provides the information

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necessary to execute the model, such as model conventions, model input, and model output. The loose-leaf format is to facilitate documentation of future enhancements to the model.

# PREFACE

This Instruction Report was prepared at the Coastal Engineering Research Center (CERC) of the US Army Engineer Waterways Experiment Station (WES) under Civil Works Research Work Unit 31592, "Wave Estimation for Design," Coastal Flooding and Storm Protection Program, Coastal Engineering Area of Civil Works Research and Development, Office, Chief of Engineers (OCE). The Technical Monitor from OCE was Mr. John H. Lockhart, Jr.

The program described in this report is a numerical model that simulates shallow-water wave growth, propagation, and decay in a directional spectrum over an arbitrary bathymetry. The model was first presented to US Army Corps of Engineers District and Division personnel during a workshop held at WES in January 1985. Subsequent enhancements to the program have altered the input and output files since the workshop. The model features described in this report are those included in the model at this writing. Future erhancements and auxiliary supporting programs will be documented as appendixes to this loose-bound report.

This report was prepared by Dr. Steven A. Hughes, Research Hydraulic Engineer, and Dr. Robert E. Jensen, Research Hydraulic Engineer, Coastal Oceanography Branch (COB), CERC, under the supervision of Dr. Edward F. Thompson, Chief, COB, Mr. H. Lee Butler, Chief, Research Division, Mr. Charles C. Calhoun, Jr., Assistant Chief, and Dr. James R. Houston, Chief, CERC. Dr. Charles L. Vincent contributed to this report both in the preparation and in the technical review. This report was edited by Ms. Shirley A. J. Hanshaw, Publications and Graphic Arts Division, WES.

Director of WES was COL Allen F. Grum, USA. Technical Director was Dr. Robert W. Whalin.

# CONTENTS

# A USER'S GUIDE TO SHALWV: NUMERICAL MODEL FOR SIMULATION OF SHALLOW-WATER WAVE GROWTH, PROPAGATION, AND DECAY

## PART I: MODEL OVERVIEW

### Introduction

1. SHALWV is a numerical model that simulates shallow-water wave growth, propagation, and decay in a directional spectrum over an arbitrary bathymetry. It is a time-dependent model requiring a primary input of the wind speed and wind direction at each grid point.

2. The purpose of this Instruction Report is to provide an overview of SHALWV followed by instructions on how to set up the necessary input files and how to execute the model on the Control Data Corporation's (vendor for US Army Corps of Engineers) Cybernet Computer System. The overview of the model is contained in Part I, which gives the model description, the theoretical background, the model applications, and the model limitations. Part II provides the information necessary to execute the model. This includes model conventions, model input, and model output with each being illustrated by examples. Examples of the job control language (JCL) specific to the Cybernet Computer System are provided in Appendix A.

### Background

3. The numerical wave model SHALWV was developed originally by Dr. Donald Resio, Offshore and Coastal Technologies, Inc., under contract to the Coastal Engineering Research Center (CERC). The model was delivered April 1984, after which work began in moving the FORTRAN source code to the CYBERNET system and making the changes necessary to compile and execute the model on the Cyber 205 computer. The model, which was extensively enhanced and expanded in its capabilities by Dr. C. L. Vincent and Dr. R. E. Jensen of CERC, includes modification of the growth parameters to the TMA spectral shape* and the addition of the ability to treat swell and rapidly changing winds. These enhancements have extended the FORTRAN code to about 3,300 lines in length.

### Model Description

4. SHALWV simulates the physical mechanisms acting on a directional

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* Steven A. Hughes. 1986. "The TMA Shallow-Water Spectrum: Description and Applications," Technical Report CERC-84-7, US Army Engineer Waterways Experiment Station, Vicksburg, Miss.

spectrum within an arbitrary depth field. The modeled spectra are represented as fully two-dimensional spectra in discrete frequency and direction bands. Physical processes which are modeled over an arbitrary bathymetry are as follows:

a. Wave propagation.

b. Wave refraction.

c. Wave shoaling.

d. Wave growth and decay.

These processes are modeled in a time-dependent mode; thus, most nonsteady-state wave and wind conditions can be handled. The model operates on a square grid with directional spectra containing up to 20 frequency bands and up to 18 directional bands. The maximum time-step interval is determined from the following Courant number stability criterion which is based on grid size and water depth:

$$\frac{\Delta \ell}{\Delta t} > C_g(f^*) \tag{1}$$

where

$\Delta \ell$ = grid spacing

$\Delta t$ = time-step

$C_g$ = wave group speed

$f^*$ = lowest frequency band specified for model during input

The criterion assures that wave energy cannot propagate more than one grid cell during a time-step. Note that $C_g$ varies with depth.

5. Recent developments on depth-limited spectra have been incorporated into the model to provide an upper limitation to wave growth.

Computer requirements

6. SHALWV is currently installed on the Cybernet Computer System under the family name KOE. Execution of the model is through a batch job that transfers the necessary files to the Cyber 205, which is a large capacity "super computer." The Cyber 205 is used for two reasons: (a) the model requires a substantial amount of computer core memory (more than is allowable on the smaller interactive Cybernet computers), and (b) the time-dependency of the model can lead to lengthy computer runs which are more efficient on the much faster Cyber 205. The model conceivably could be installed on a smaller machine with a large virtual memory capacity, but this probably is not a simple

task. Some sections of the model might have to be modified to accommodate the transfer, and the model execution would probably tie up the entire core memory for a long time. Therefore, it is recommended that the model not be transferred to a smaller machine except by very experienced personnel.

Simulation costs

7. Because of the many variables involved in model simulations, it is possible to provide only approximate cost estimates for execution of this model. By way of example, a 12 by 19 grid of Lake Erie containing 94 water grid points and run for 12 time-steps (4-hr simulation) costs $18. The same problem run for 24 time-steps (8 hr) costs $23. A 14 by 15 (42- by 45-km) grid in the Atlantic off Duck, North Carolina, ran for 126 time-steps (7-hr simulation) at a cost of approximately $120.

## Theoretical Foundation

8. This section describes the theoretical background of SHALWV. No attempt is made to discuss the actual mathematical formulations and the method of representing these formulations in the model.

9. SHALWV employs an explicit finite-difference scheme to solve the following spectral balance equation:

$$\frac{DE(f,\theta)}{Dt} = \sum_{i} S_i \qquad (2)$$

In this equation the left-hand term is the total derivative of the directional energy density, and it contains: (a) a term representing the temporal change in the spectral energy density, (b) terms representing the advection of wave energy, and (c) refraction and shoaling terms. The right-hand side of Equation 2 consists of the source terms representing physical mechanisms that add to or subtract from net energy to the wave field. These source terms include atmospheric energy input, nonlinear wave-wave interactions, bottom friction, bottom percolation, wave dissipation within the wave field, bottom motion, bottom scattering, and surf zone breaking. The numerical model SHALWV contains the first four source terms (atmospheric input, wave-wave interactions, bottom friction, and percolation) and has a finite-depth spectral limit which acts to constrain wave growth in lieu of a source term for wave dissipation by breaking.

### Propagation

10. Propagation of the wave energy in each discrete frequency-direction band is done independently using an upstream differencing scheme. This is a stepwise solution that estimates for each discrete band the wave ray along which the energy contained in that band must propagate in order to arrive at the grid point of interest by the end of the time-step (Figure 1). Point A on Figure 1 represents the location of the wave energy contained in the discrete frequency-direction band at the beginning of the time-step. An estimate of this energy is obtained by an interpolation method that first projects the wave ray farther back in time until a grid boundary is crossed (point B in Figure 1). Finally this estimated energy is propagated along the wave ray as refraction and shoaling effects are estimated, reaching the grid point (C) at the end of the time-step. During the propagation, energy is added to or removed from each discrete energy band by the source terms. At the end of the time-step, the directional spectrum at each grid point is the sum of the independently propagated spectral elements. Since the grid spacing can be large, assumptions about smooth bathymetry are inherent.

### Source terms

11. The SHALWV model assumes that the primary source mechanisms for

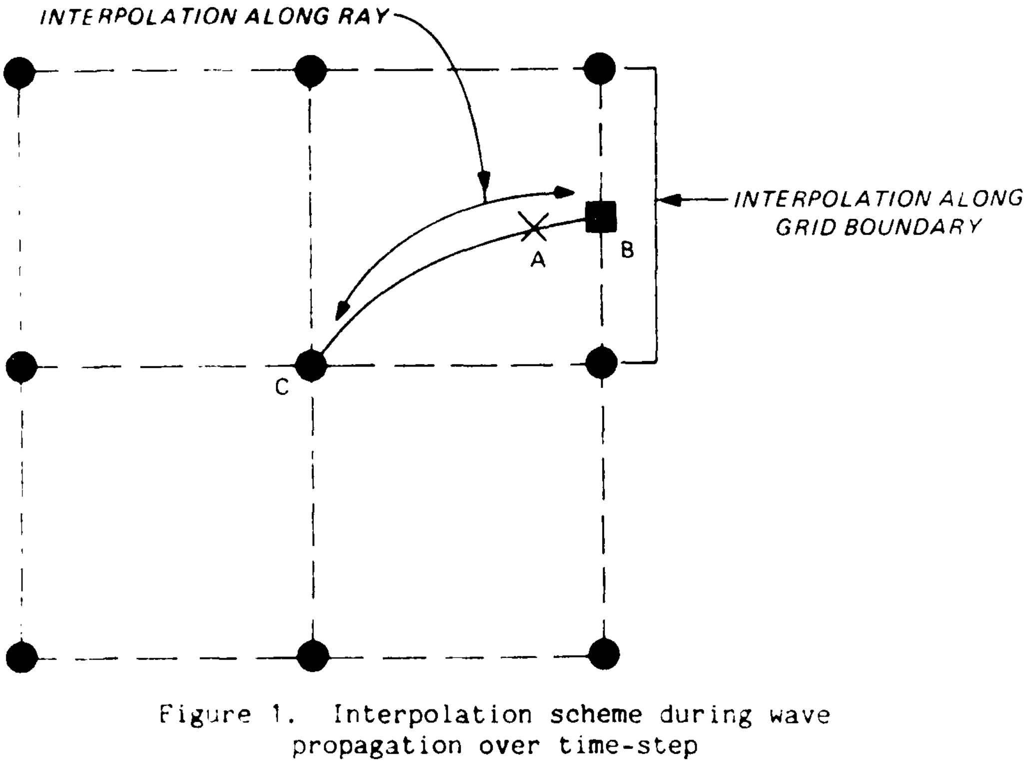

Figure 1. Interpolation scheme during wave propagation over time-step

storm waves in shallow water are the atmospheric energy input, the nonlinear wave-wave interactions, and internal wave field dissipation. It is assumed that bottom friction and percolation become important only in certain instances, such as swell on a gentle bottom slope. Bottom friction and percolation can be activated by the user if desired for the swell components of the model.

12. Figure 2 illustrates the relative effect that the primary source terms (as assumed by this model) have on a wind sea spectrum. The atmospheric source term is formulated such that the energy addition due to wind stress is confined primarily at the peak of the spectrum and to the rear face of the spectrum (regions II and III in Figure 2) in deep water. During fully developed conditions, the waves at frequencies less than the peak travel at speeds equal to or greater than the wind speed; thus wind energy cannot be transferred directly to the sea surface. As the water depth decreases, the lower

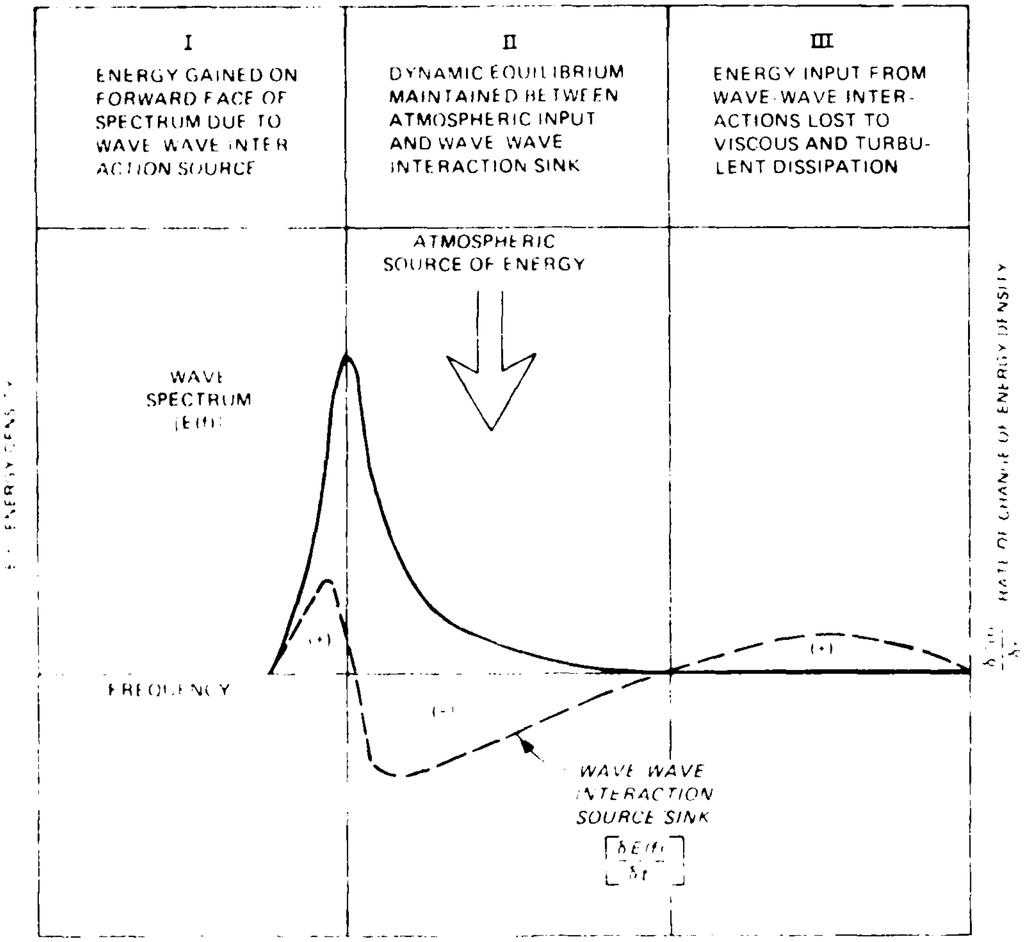

Figure 2. A typical spectrum during a period of active wave growth

frequency waves become nondispersive and begin to travel at a celerity primarily dependent upon the depth. SHALWV assumes that as waves approach the nondispersive limit in shallow water, the forward face of the spectrum becomes incapable of receiving direct atmospheric input, as well as becoming incapable of transferring energy from the midrange frequencies through wave-wave interactions.

13. The hatched line in Figure 2 represents the relocation of wave energy between frequencies via the nonlinear wave-wave interactions. Energy is shifted in both directions from region II. Energy shifted to higher frequencies (region III) is dissipated through viscous and turbulent processes. The model "loses" this energy by limiting the rear face of the spectrum to the depth-limited spectral form. Energy shifted to the lower frequencies contributes to wave growth and the eventual shifting of the spectral peak to lower frequencies which in turn allows the midrange to accept more energy through wind stress. The wave-wave interaction term is sensitive to both the energy contained in the spectrum and the shape of the spectrum.

14. The model contains a procedure for the transformation of swell wave energy. This situation can arise either by the input of a bimodal spectrum at the onset of a simulation, by turning off the winds at some point during the simulation, or by migration of the spectral peak out of the growth range. After each time-step the newly estimated wind sea spectrum at each grid point is subtracted from the total spectrum. Any remaining energy at frequencies less than the peak of the wind sea spectrum is treated as swell. The model then determines the peak frequency of the swell and the total swell energy. It computes the alpha and the wave-wave interaction term for the swell, and it then finds the new peak of the swell.

15. As mentioned, bottom friction and percolation are not considered important in the wind sea components in this model; however, source terms for bottom friction and percolation are present which allow the user to include these effects for swell and to select values for the coefficient of friction and the coefficient of percolation. The effect of bottom friction and percolation is to decrease the energy levels. Bottom friction and percolation are not contained in the wind sea balance because the empirical TMA relationships for wave growth are believed to have accounted for their effect.

### Boundary conditions

16. The original version of SHALWV required that all wave energy be

"grown" from an initially flat sea surface. This made modeling of unlimited fetch regions very difficult and costly, and simulations of bimodal spectra and many prototype events were not possible. This drawback has been rectified by a feature in the model which allows it to initialize each grid point with a specified directional wave energy spectrum. Additionally, the incoming wave energy at the boundaries can be updated during model execution to simulate actual prototype boundary conditions and to prevent "leakage" of wave energy out the side boundaries (in an open coast situation). A separate program which provides the optional initial and boundary conditions for SHALWV has been coded by Dr. Robert E. Jensen of CERC.

## Model Applications and Limitations

17. SHALWV in its present form is one of the most versatile of CERC's shallow-water wave models. It is particularly well suited for situations described by combinations of the following features in finite depth water:

a. Enclosed bodies of water.
b. Open coasts (with additional codes).
c. Arbitrary bathymetry.
d. Nonsteady-state wind or wave conditions.
e. Shallow-water or deepwater wave growth.
f. Swell wave transformation.
g. Fetch- or duration-limited wave growth.
h. Unlimited fetch and/or unlimited duration cases.
i. Very lengthy time simulations (hindcasts).
j. Rapidly turning winds (e.g. hurricanes).

18. Limitations of the SHALWV numerical model can be given in two categories. Physical limitations refer to those physical processes or situations which are not represented in the model. Some physical limitations are the following:

a. No interactions with currents (e.g. vicinity of inlets).
b. No interaction with coastal structures.
c. No diffraction (e.g. diffraction behind islands, though islands can be handled).
d. No variation of still water level with time (e.g. storm surge) which would affect the results in very shallow water.

Some of the above limitations may be rectified by future code enhancements. Computational limitations are functions of the numeric scheme employed in the model, or they can be limitations resulting from large core memory requirements. Some computational limitations of the present version of SHALWV are that it

a. Allows no variable grids or boundary fitted grids.

b. Requires a large, fast computer.

c. Runs as a batch job.

d. Has stability dependent upon Courant number (i.e., smaller grid means smaller time-step which means more expense).

# PART II: MODEL EXECUTION

## Program Organization

### Run types

19. An important feature of the present model formulation is that all time invariant interpolation constants are computed and stored in arrays prior to the initiation of the time loop. This is termed "preprocessing," and it is an efficient scheme for time-dependent models, but it also rules out any simulations involving a time varying water level. A change of water level would require the recalculation of all interpolation constants.

20. There are three versions of the JCL batch jobs which can be run. The first, PREPJCL, is a preprocessing run only. It gathers the necessary input files and calculates only the time invariant constants for the given bathymetry and specified parameters. The calculated information is saved as a binary file for use in a production run. The second batch job, PRODJCL, reads the file previously saved by PREPJCL and then proceeds with the wave simulation. None of the parameters set during the preprocessing run can be reset during a production run. Two advantages of this arrangement are (a) several different simulations at the same site can be performed without having to recalculate the time invariant portions, and (b) the initial debugging of the input files is less expensive. The third batch job, PRPOJCL, preprocesses and then continues with the simulation. This job stream is useful when small changes are made to the input which necessitate preprocessing. An example would be a change in the bathymetry file. Note, however, that PRPOJCL does not save the preprocessing file for future use. These three run options of SHALWV are shown on the simple flowchart in Figure 3. When setting up runs, care must be taken with regard to some statements in the JCL files that purge old files, override existing files, or initialize new files. Also, long simulations over the same grid can create some very large output files that build up storage costs.

### Preprocessing

21. The first step of model preprocessing is to read the model input parameters. This includes parameters such as numbers of rows and columns in the grid, the grid dimensions, the time-step, etc. There are quite a few parameters which allow the user to select various program options. At the

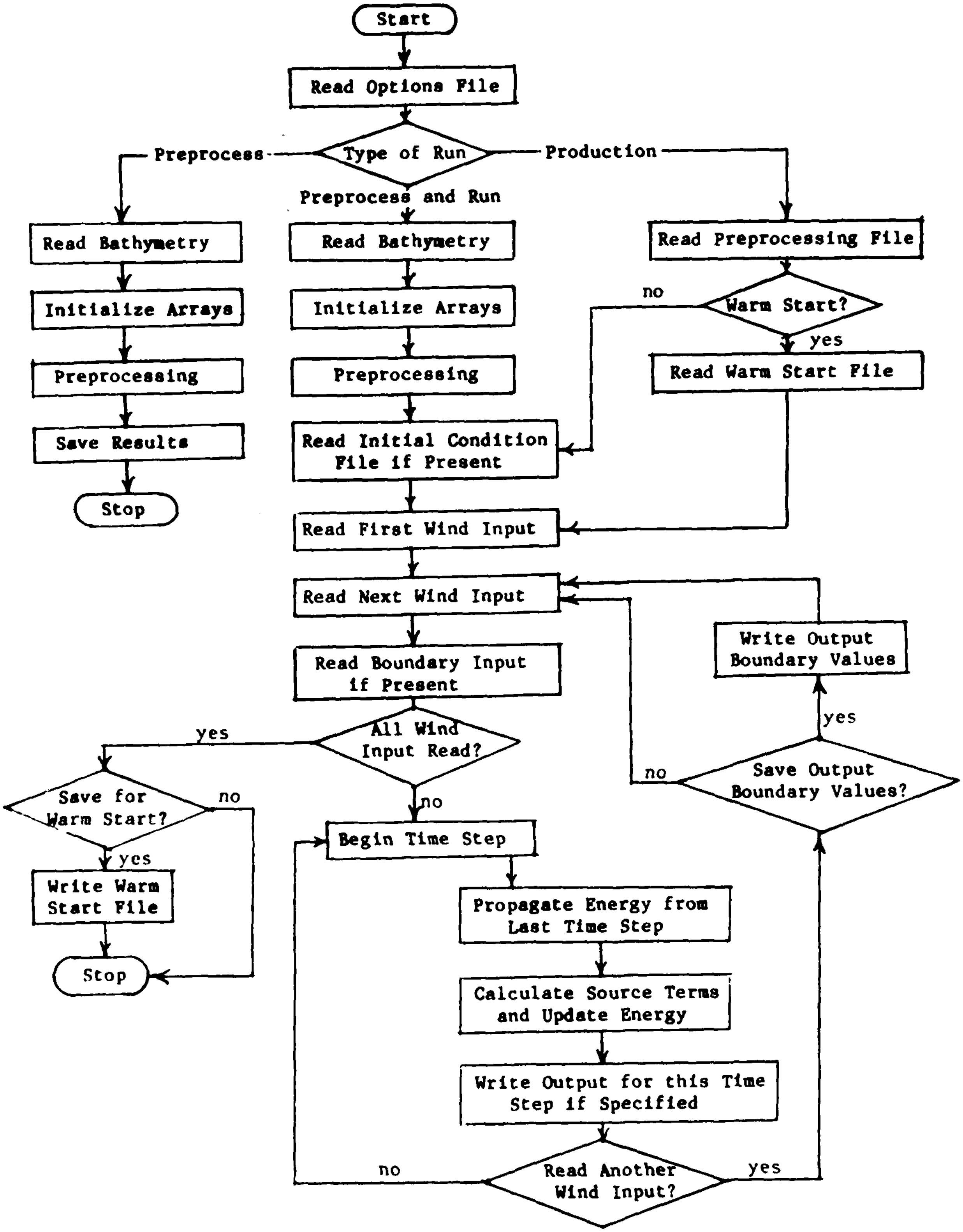

Figure 3. Model flowchart

same time the bathymetry is read and converted to meters. Reading of the input data is followed by the second step, initialization of the working arrays. The third step is the calculation of the time-invariant data used by the propagation routines which calculate such depth related parameters as phase and group velocities for all frequencies at all water grid points. They also calculate a host of interpolation constants related to refraction and shoaling. These steps are illustrated in the flowchart in Figure 3.

## Wave simulation

22. After preprocessing, the program can read optionally an initial condition file. This file will preset directional spectral energy levels at every water grid point in the model. This ability is one of the most useful features of the model because it allows simulations over regions where the boundary or initial conditions are known. An example is an open body of water. Without this feature, the model grid would have to be big enough to extend past fetch-limited growth and thus could become very expensive.

23. The program now enters into the time-dependent nested loops. In the outer loop, the first and second wind files are read. This enables linear interpolation for wind speed and wind direction at each time-step. Next, a boundary input is read if this option is in effect. The program then enters the inner loop where the actual spectral calculations are performed for each time-step. A series of routines in this inner loop propagate, refract, and shoal wave energy and update the energy as determined from the source term calculations. At the end of each time-step, the one- and two-dimensional spectra and the one-line summaries are written to files (if the user selects this option); and a new time-step is begun. When it is time to read another wind file, the program goes to the outer loop. Another enhancement allows output of directional spectra at specified grid points to serve as boundary input for a nested grid application; however, running of a nested grid requires an additional code. Finally, after all wind files have been read and processed, the program will save (if requested) all necessary data for a future warm start.

## Grid conventions

24. The grid used by SHALWV is a framework of orthogonal lines forming squares of uniform size. Any point in the grid may be denoted by I,J coordinates as shown in Figure 4. A potential point for confusion in this grid convention is the numbering of the rows from the bottom to the top of the grid.

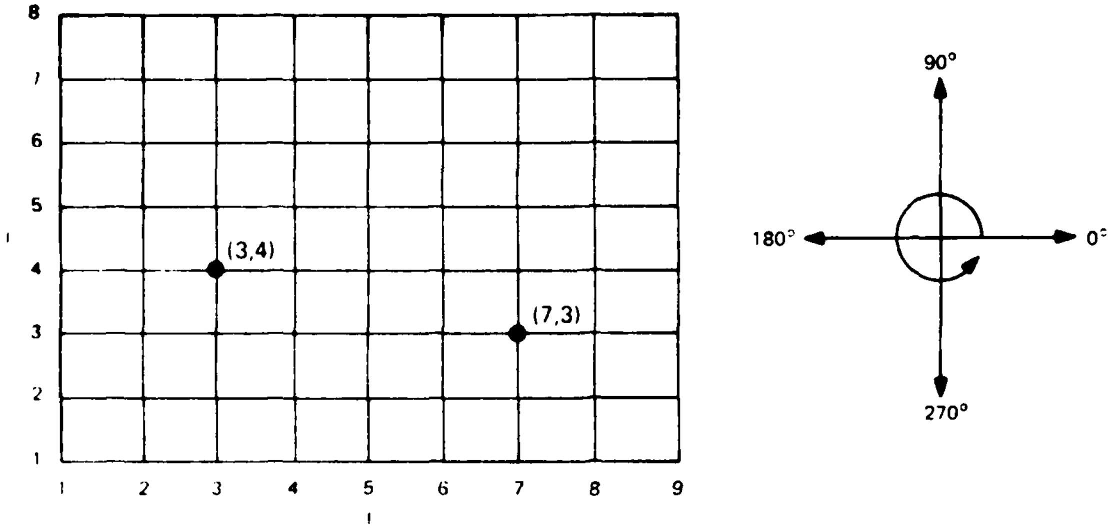

Figure 4. Model grid and angle conventions

Figure 4 also shows the model's convention for directions. Input wind directions and output wave directions are in a "going to" form (i.e., wind and wave directions are the direction from which they came) with 0 deg being parallel to the rows with the angle increasing in a counterclockwise rotation. For example, in the grid shown, winds blowing from the bottom of the grid to the top of the grid would have an angle of 90 deg. This direction convention is also a source of possible confusion since it is contrary to the conventional compass rose. Consequently, caution should be exercised when (a) specifying grid points by I,J coordinates, (b) specifying input wind angles, and (c) interpreting output wave angles.

## The parameter statement

25. SHALWV contains a parameter statement in the source listing which acts to set the dimensions for most of the model's arrays. An example statement is given below.

```
PARAMETER (IDMN=16,JDMN=16,IF=20,IA=20,NBPS=35)
```

Each item in the PARAMETER statement is explained below.

| Parameter Name | Explanation |
|---|---|
| IDMN | Maximum number of grid columns |
| JDMN | Maximum number of grid rows |
| IF | Maximum number of frequency bands |
| IA | Maximum number of angle bands |
| NBPS | Maximum number of input boundary points |

The above values must be greater than or equal to the corresponding parameters specified in the input file. If a grid larger than allowed by the parameter statement is desired, it is necessary to change the value in the parameter statement to accommodate the increased size, and usually it will be necessary to make changes to some of the JCL statements. The PARAMETER statement occurs 25 times in the source code, and all 25 statements must be changed so that they agree. When the user fails to make the values in the PARAMETER statements large enough for the grid, the usual fatal error message is "indefinite result." This stems from attempting an algebraic operation with an array element that does not exist. If the values in the PARAMETER statements get too large (e.g., a 100 by 100 grid), even the supercomputers will not have enough core memory to run the job.

## Model Input Files

26. SHALWV accepts up to a total of six input files; three originate from the front-end computer, and three are created and stored on the Cyber 205 (or similar class large computer). The input files are given below.

### Tape 20

27. This file contains the parameters and options selected by the user. It is required for all three batch job streams. It is a front-end file.

### Tape 25

28. This file contains the bathymetry. It is required for batch jobs PREPJCL and PRPOJCL. It is a front-end file.

### Tape 21

29. This file specifies the winds over the grid. It is required for batch jobs PRODJCL and PRPOJCL. It is a front-end file.

### Tape 33 (Prep)

30. This is a binary file created by the batch job PREPJCL and stored on the large computer. It contains all the preprocessing information, and it is called by the batch job PRODJCL. This file will not be created by PRPOJCL.

### Tape 15 (Warm)

31. This is a binary tape which can be written by either PRODJCL or PRPOJCL. It contains information necessary for a "warm start," i.e., the continuation of a simulation. This is saved on the large computer.

### Tape 31 (Bndyin)

32. This is a file containing specified initial and boundary conditions. It is saved on the large computer, and it can be called by either PRODJCL or PRPOJCL. This file is created by a separate program.

### Model parameters input (Tape 20)

33. Input for preprocessing, PREPJCL. The following input parameters need to be specified for a preprocessing run. Figure 5 is a sample input file used for model runs at the Field Research Facility (FRF) at Duck, North Carolina. Each parameter is explained below. Values given in parentheses are from the example in Figure 5 and are included only for clarification. They are not default values.

```
   1
  14   15   16   14    0    1
       3.        10.     200.   0.3048
 0.060 0.010
00000000000000
01111111111110
01111111111110
01111111111110
01111111111110
01111111111110
01111111111110
01111111111110
01111111111110
01111111111110
01111111111110
01111111111110
01111111111110
01111111111110
00000000000000
```

Figure 5. Sample parameter input file for preprocessing run

a. 1st Card - Format(I4).

IPREP - Run type (1), IPREP = 1 preprocess and stop (this example)
= 2 production run
= 3 preprocess and run

b. 2nd Card - Format(6I4).

NX - Number of columns in grid (14)

NY - Number of rows in grid (15)

NANG - Number of directional angle bands (16)

NFRC - Number of frequency bands (14)

INDELF - Flag on frequency band read (0)
  = 0 internally computes frequency bands
  = 1 reads frequency bands

IDEPD - Flag on water depth read of Tape 25 (1)
  = 0 read in constant water depth
  = 1 read in variable water depths

c. 3rd Card - Format(3F8.0,F8.4).

DL - Distance between grid points in kilometers (3.0)

XN - A scale factor used in refraction computations expressed as a percentage of DL (10.0) (A value of 10 is recommended. A larger number increases computational costs; a lower number decreases refraction computation accuracy.)

DT - Time-step in seconds (200.0)

DEPFAC - Factor to convert input depths to meters (0.3048)

d. 4th Card.

IF INDELF = 0, Format(2F6.3)

OMST - Starting frequency band (0.060)
DOMEG - Frequency interval (0.010)

IF INDELF = 1, Format(10F6.3)

OMEG(K), K=1,NFRC - Read in frequency bands, can take two cards

e. 5th Card - Format(21I1).

IBOUND(I,J) - Array designating grid points as water, land, or boundary points (All outer grid points must be denoted as boundary points. This array must be the same size as the bathymetry array.)
  = 0 boundary point
  = 1 water point

This ends the Tape 20 input file for the batch job PREPJCL.

34. Input for Production Run, PRODJCL. The following input parameters need to be specified for a production run. Figure 6 is a sample input file used for model runs at the FRF. Each parameter is explained below. Values given in parentheses are from the example in Figure 6 and are included only for clarification. They are not default values.

a. 1st Card - Format(I4).

IPREP - Run type (2), IPREP = 1 preprocess and stop
  = 2 production run (this example)
  = 3 preprocess and run

```
 2
 2   2   2   1
18   1  10   3
5  4
5  8
5 12
35
 2  14
 3  14
 4  14
 5  14
 6  14
 7  14
 8  14
 9  14
10  14
11  14
12  14
13  14
13  13
13  12
13  11
13  10
13   9
13   8
13   7
13   6
13   5
13   4
13   3
13   2
12   2
11   2
10   2
 9   2
 8   2
 7   2
 6   2
 5   2
 4   2
 3   2
 2   2
```

Figure 6. Sample parameter input file for production run

b. 2nd Card - Format(I4).

LWST - Flag for WARM/COLD, SAVE/NO SAVE run (2)
= 0 cold start, no save
= 1 warm start, no save

= 2 cold start, save
= 3 warm start, save

IBTY - Flag for boundary condition input and output (2)
= 0 no input or output boundary conditions
= 1 output boundary information (Tape 30)
= 2 input boundary information (Tape 31)
= 3 input and output boundary information

NORD - Flag for wind input read (2)
= 1 constant over time and space
= 2 variable over time, constant over space
= 3 variable over time and space

NOBE - Flag for bottom effects (1)
= 1 no bottom effects
= 2 include bottom effects

c. 3rd Card (optional) - Format(2F10.5).

IF NOBE = 2, this card is read; otherwise do not include this card.

BCOF - Bottom friction coefficient
PCOF - Bottom percolation factor in cm/sec

d. 4th Card - Format(I4).

NTMS - Number of time-steps between output results (18)

NHR - Number of hours between input winds (1)

MXHR - Maximum number of wind inputs (10)

MSTA - Number of special output locations, not to exceed 10 (3) (These are the grid points where detailed spectral wave data are saved.)

e. 5th Card(s) - Format(2I4).

IOUT(K) - Column (I) location of special output point

JOUT(K) - Row (J) location of special output point

There must be a total of MSTA of these cards, one for each location.

Note: The cards from this point pertain to the input or output of boundary information. To make use of the data specified by these cards additional codes are required.

f. 6th Card (optional) - Format(I4).

IF IBTY = 1 or 3, this card is read; otherwise do not include this card (not included in Figure 6 example).

NOBS - Number of output locations

g. 7th Card(s) (optional) - Format(2I4).

IF IBTY = 1 or 3, a total of NOBS cards must be provided, one card per output boundary point.

LOUTB(K,1) - Column (I) location of boundary output location

LOUTB(K,2) - Row (J) location of boundary output location

where K = 1, NOBS

h. 8th Card (optional) - Format(I4).

IF IBTY = 2 or 3, this card is read; otherwise do not include this card (included in this example).

NIBS - Number of input boundary locations (35)

i. 9th Card(s) (optional) - Format(2I4).

IF IBTY = 2 or 3, a total of NIBS cards must be provided, one card per each input boundary point.

LINB(K,1) - Column (I) location of boundary input location

LINB(K,2) - Row (J) location of boundary input location

where K = 1, NIBS

CAUTION: these cards must be specified in the exact order specified in the boundary generator program.

This ends the Tape 20 input file for the batch job PRODJCL.

35. Input for preprocessing and production run, PRPOJCL. The input file for a preprocessing and production run is a combination of the preprocessing cards and the production cards. No example is provided for this case.

a. 1st Card - Format(I4).

IPREP - run type (2), IPREP = 1 preprocess and stop
= 2 production run
= 3 preprocess and run (this example)

b. Cards 2 through 5.

These cards will be identical to cards 2 through 5 of a preprocessing (PREPJCL) run.

c. Cards 6 through 13.

These cards will be identical to cards 2 through 9 of a production (PRODJCL) run.

This ends the Tape 20 input file for the batch job PRPOJCL.

Bathymetry input (Tape 25)

36. The bathymetry grid is an array containing positive values of depth at each grid point. Depths can be in any units, but units cannot be mixed within the grid. Large grids are handled by reading successive cards until the entire row is read. The next row begins on a new card. An example is shown in Figure 7, which is the bathymetry file (in feet) used for simulations at the FRF.

```
   0.0  45.0  50.0  55.0  65.0  60.0  84.0  81.0  79.0  82.0  85.0  90.0  78.0  99.0
   0.0  45.0  50.0  55.0  65.0  60.0  84.0  81.0  79.0  82.0  85.0  90.0  78.0  99.0
   0.0  52.0  65.0  56.0  72.0  70.0  78.0  80.0  78.0  84.0  87.0  84.0  80.0  99.0
   0.0  43.0  47.0  67.0  65.0  76.0  80.0  82.0  84.0  90.0  96.0  84.0  84.0  99.0
   0.0  40.0  58.0  65.0  71.0  77.0  85.0  84.0  87.0  90.0  93.0  84.0  84.0  99.0
   0.0  45.0  70.0  70.0  79.0  85.0  83.0  85.0  90.0  90.0  90.0  90.0 102.0  99.0
   0.0  50.0  67.0  60.0  70.0  92.0  83.0  85.0  92.0  95.0 100.0 104.0 108.0  99.0
   0.0  50.0  56.0  62.0  80.0  87.0  84.0  85.0  90.0  97.0  97.0  93.0  94.0  99.0
   0.0  50.0  67.0  65.0  60.0  84.0  82.0  84.0  92.0  94.0  98.0  90.0 100.0  99.0
   0.0  50.0  67.0  61.0  79.0  83.0  80.0  85.0  84.0  97.0  94.0 100.0 110.0  99.0
   0.0  54.0  66.0  65.0  64.0  80.0  77.0  80.0  87.0  92.0 103.0 100.0  97.0  99.0
   0.0  45.0  68.0  68.0  74.0  71.0  78.0  78.0  78.0 102.0 100.0 101.0 105.0  99.0
   0.0  42.0  68.0  62.0  78.0  80.0  85.0  90.0  79.0  85.0 100.0 104.0 105.0  99.0
   0.0  35.0  70.0  61.0  63.0  82.0  70.0  90.0  70.0  73.0  90.0 106.0 110.0  99.0
   0.0  35.0  70.0  61.0  63.0  82.0  70.0  90.0  70.0  73.0  90.0 106.0 110.0  99.0
```

Figure 7. Sample bathymetry grid file input

IF IDEPD = 0 (Tape 20), Format(F6.1)

DEPCO - Uniform (constant) water depth over entire grid

IF IDEPD = 1 (Tape 20), Format(20F6.1)

DEP(I,J) - Array containing water depths at all grid points (This array must be the same size as the IBOUND array on Tape 20.)

Wind input (Tape 21)

37. The wind input file is required for all runs of the batch jobs PRODJCL and PRPOJCL. A wind field can be input as either a single card specifying a uniform and constant wind speed and wind direction over the entire grid, or it can be in the form of arrays which give the wind speed and direction at each grid point. The wind file can contain any number of wind fields, but it must contain at least two. When wind fields are not input at every time-step, a linear interpolation is performed to obtain the intermediate values at each grid point.

a. Uniform wind fields - Format(2F6.1).

For values of NORD = 1 or 2 (from Tape 20), wind speed and wind direction are assumed not to vary over the grid. The input is then

TSWS - Uniform wind speed in knots over entire grid assumed to be overwater, neutrally stable atmospheric conditions at the 10-m elevation

TSDIR - Uniform wind direction in degrees over entire grid expressed relative to direction convention discussed before

IF NORD = 1, only one card is read.

```
21.3 157.0
20.7 152.0
23.1 131.0
24.6 130.0
28.0 110.0
32.2 106.5
25.1  70.0
25.3  23.0
28.7  16.0
28.0  19.0
```

Figure 8. Sample wind file input for a uniform wind field varying over time

IF NORD = 2, there will need to be MXHR cards with the above format.

Figure 8 is an example of the wind file for uniform wind fields changing every hour for 9 hr.

b. Variable wind fields. When NORD = 3 (from Tape 20), the wind fields are assumed to be variable over space and time. Each wind field must be organized as follows:

1st Card - Format(I10)

ID - date/time code

Wind Speed Array - Format(21F6.1)

WS(I,J) - wind speeds in knots over the entire grid

Wind Direction Array - Format(21F6.1)

WD(I,J) - wind direction in degrees over the entire grid expressed relative to direction convention discussed before.

Figure 9 gives an example of a variable wind field. The wind direction array immediately follows the wind speed array. For

```
8109190800
  19.1  19.1  19.1  19.1  19.1  19.1  19.1  19.1  19.1  19.1  19.1  19.1  19.1
  19.1  20.0  20.0  20.0  20.0  20.0  20.0  20.0  22.0  20.0  22.0  19.1  19.1
  19.1  20.0  20.0  20.0  20.0  20.0  20.0  20.0  22.0  20.0  22.0  19.1  19.1
  19.1  21.0  21.0  21.0  21.0  21.0  21.0  21.0  22.0  22.0  22.0  19.1  19.1
  19.1  22.0  22.0  22.0  22.0  22.0  22.0  22.0  22.0  22.0  22.0  21.1  19.1
  19.1  23.0  23.0  23.0  23.0  23.0  23.0  22.0  22.3  22.3  22.3  21.1  19.1
  19.1  22.0  22.0  22.0  21.0  21.0  21.0  19.1  19.1  21.0  21.0  21.0  19.1
  19.1  19.1  19.1  19.1  19.1  19.1  19.1  19.1  19.1  19.1  19.1  19.1  19.1
  19.1  20.0  20.0  20.0  21.0  21.0  21.0  21.0  20.0  20.0  20.0  20.0  19.1
  19.1  20.0  20.0  21.0  21.0  23.0  23.0  23.0  23.0  24.0  24.0  24.0  19.1
  19.1  20.0  20.0  20.0  20.0  20.0  20.0  21.0  21.0  21.0  21.0  19.1  19.1
  19.1  21.0  21.0  21.0  21.0  21.0  22.0  22.0  22.0  21.0  22.1  19.1  19.1
  19.1  19.1  24.0  24.0  24.0  24.0  24.0  24.0  24.0  24.0  24.0  19.1  19.1
  19.1  19.1  19.1  19.1  19.1  19.1  19.1  19.1  19.1  19.1  19.1  19.1  19.1
 110.0 110.0 110.0 110.0 110.0 110.0 110.0 110.0 110.0 110.0 110.0 110.0 110.0
 110.0 110.0 110.0 110.0 110.0 110.0 110.0 110.0 110.0 110.0 110.0 110.0 110.0
 110.0 150.0 150.0 115.0 140.0 145.0 145.0 143.0 143.0 143.0 143.0 143.0 110.0
 110.0 150.0 150.0 140.0 140.0 140.0 140.0 140.0 140.0 130.0 130.0 130.0 110.0
 110.0 145.0 145.0 145.0 145.0 145.0 145.0 145.0 145.0 145.0 145.0 145.0 110.0
 110.0 145.0 143.0 143.0 145.0 134.0 134.0 133.0 133.0 133.0 133.0 133.0 110.0
 110.0 145.0 145.0 134.0 134.0 134.0 134.0 133.0 133.0 133.0 132.0 132.0 110.0
 110.0 144.0 140.0 140.0 140.0 140.0 130.0 133.0 113.0 130.0 130.0 130.0 110.0
 110.0 144.0 144.0 144.0 140.0 140.0 140.0 140.0 130.0 130.0 120.0 122.0 110.0
 110.0 140.0 140.0 140.0 140.0 130.0 130.0 120.0 120.0 124.0 124.0 124.0 110.0
 110.0 140.0 134.0 134.0 134.0 130.0 130.0 120.0 120.0 120.0 115.0 110.0 110.0
 110.0 135.0 135.0 124.0 124.0 125.0 125.0 125.0 120.0 120.0 120.0 110.0 110.0
 110.0 125.0 125.0 125.0 125.0 122.0 122.0 123.0 116.0 115.0 115.0 115.0 110.0
 110.0 110.0 110.0 110.0 110.0 110.0 110.0 110.0 110.0 110.0 110.0 110.0 110.0
```

Figure 9. Sample of a spatially variable wind field input

grids with more than 21 columns, the first 21 columns of all rows are read first. This is followed by reading columns 22-42 of all rows, etc. The arrays in the wind field must agree in dimension with the bathymetry array. The J=1 row is the bottom row, just as in the bathymetry grid. There must be MXHR (Tape 20 parameter) wind fields present in the wind file.

## Model Output

38. SHALWV outputs up to six files; three are always output to the front end computer and saved under the user's directory, one is called back interactively from the Cyber 205, and two optional output files reside on the 205 system for future use. The output files are as follows:

| File Name | Information It Contains |
|---|---|
| Output | Computer run and the input data |
| Tape 10 | Two-dimensional energy spectra |
| Tape 11 | Statistical summaries |
| Tape 13 | One-dimensional energy spectra |
| Tape 30 | Two-dimensional spectra meant to serve as boundary input for a future run (optional) |
| Tape 15 | Necessary information for a warm start (optional) |

### Model output file

39. This file must be retrieved interactively after the run has been completed. Its primary contents are (a) the compiled (unmapped) source listing, (b) verification of program options entered by the parameter input file, (c) various statements indicating the progress of the program during execution, (d) tables of the combined significant wave height, peak spectral wave period, and mean wave direction at every grid point every time a new wind file is input during execution, and (e) a dayfile giving the sequence of job execution on the Cyber 205 and on the front-end machine. Only items a, b, and e are included in a preprocessing run.

40. Figure 10 shows an example of the start of the output directly below the compiled listing. Figure 11 is a sample of the periodic output over the entire grid.

41. After this file has been retrieved interactively, it must be saved in the user's directory if so desired. It is not automatically placed in the directory. Significant storage savings can be made by deleting the compiled

```
THIS RUN CONSISTS OF A READ PREPROCESS AND RUN WAVES .
** NOTE ALL INFORMATION READ FROM FILE.
THIS RUN HAS A COLD START WITH A SAVE.
NUMBER OF ROWS IN GRID =   15
NUMBER OF COLUMNS IN GRID =   14
DISTANCE IN METERS BETWEEN GRID POINTS =      3000.00000
THERE ARE 14 FREQUENCIES
FREQUENCY BANDS WERE COMPUTED INTERNALLY.
  .0600  .0700  .0800  .0900  .1000  .1100  .1200  .1300  .1400  .1500
  .1600  .1700  .1800  .1900
THE 14 FREQUENCY BAND WIDTHS ARE
  .0100  .0100  .0100  .0100  .0100  .0100  .0100  .0100  .0100  .0100
  .0100  .0100  .0100  .0100
THERE ARE  16 DIRECTION BANDS.
  EACH DIRECTION BAND WIDTH IS  22.5 DEGREES.
       .0    22.5    45.0    67.5    90.0   112.5   135.0   157.5   180.0   202.5
    225.0   247.5   270.0   292.5   315.0   337.5


BOUNDARY CONDITION INFORMATION
         0  0  0  0  0  0  0  0  0  0  0  0  0  0
         0  1  1  1  1  1  1  1  1  1  1  1  1  0
         0  1  1  1  1  1  1  1  1  1  1  1  1  0
         0  1  1  1  1  1  1  1  1  1  1  1  1  0
         0  1  1  1  1  1  1  1  1  1  1  1  1  0
         0  1  1  1  1  1  1  1  1  1  1  1  1  0
         0  1  1  1  1  1  1  1  1  1  1  1  1  0
         0  1  1  1  1  1  1  1  1  1  1  1  1  0
         0  1  1  1  1  1  1  1  1  1  1  1  1  0
         0  1  1  1  1  1  1  1  1  1  1  1  1  0
         0  1  1  1  1  1  1  1  1  1  1  1  1  0
         0  1  1  1  1  1  1  1  1  1  1  1  1  0
         0  1  1  1  1  1  1  1  1  1  1  1  1  0
         0  1  1  1  1  1  1  1  1  1  1  1  1  0
         0  0  0  0  0  0  0  0  0  0  0  0  0  0


BATHYMETRY, IN METERS

  I      1     2     3     4     5     6     7     8     9    10    11    12    13    14
 J
15      .0  13.7  15.2  16.8  19.8  18.3  25.6  24.7  24.1  25.0  25.9  27.4  23.8  30.2
14      .0  13.7  15.2  16.8  19.8  18.3  25.6  24.7  24.1  25.0  25.9  27.4  23.8  30.2
13      .0  15.8  19.8  17.1  21.9  21.3  23.8  24.4  23.8  25.6  26.5  25.6  24.4  30.2
12      .0  13.1  14.3  20.4  19.8  23.2  24.4  25.0  25.6  27.4  29.3  25.6  25.6  30.2
11      .0  12.2  17.7  19.8  21.6  23.5  25.9  25.6  26.5  27.4  28.3  25.6  25.6  30.2
10      .0  13.7  21.3  21.3  24.1  25.9  25.3  25.9  27.4  27.4  27.4  27.4  31.1  30.2
 9      .0  15.2  20.4  18.3  21.3  28.0  25.3  25.9  28.0  29.0  30.5  31.7  32.9  30.2
 8      .0  15.2  17.1  18.9  24.4  26.5  25.6  25.9  27.4  29.6  29.6  28.3  28.7  30.2
 7      .0  15.2  20.4  19.8  18.3  25.6  25.0  25.6  28.0  28.7  29.9  27.4  30.5  30.2
 6      .0  15.2  20.4  18.6  24.1  25.3  24.4  25.9  25.6  29.6  28.7  30.5  33.5  30.2
 5      .0  16.5  20.1  19.8  19.5  24.4  23.5  24.4  26.5  28.0  31.4  30.5  29.6  30.2
 4      .0  13.7  20.7  20.7  22.6  21.6  23.8  23.8  23.8  31.1  30.5  30.8  32.0  30.2
 3      .0  12.8  20.7  18.9  23.8  24.4  25.9  27.4  24.1  25.9  30.5  31.7  32.0  30.2
```

Figure 10. Beginning of a sample output file

```
ID, IHR, KTIME          1    3    19


HMO IN METERS OVER GRID
   .00    .00    .00    .00    .00    .00    .00    .00    .00    .00    .00    .00    .00     .00
   .00   3.90   3.89   3.88   3.88   3.88   3.94   3.94   3.94   3.94   3.96   3.99   4.14     .00
   .00   2.40   2.76   2.98   3.05   3.41   3.53   3.67   3.90   4.05   4.24   4.26   4.14     .00
   .00   2.71   2.84   2.95   3.06   3.14   3.49   3.55   3.71   3.93   4.11   4.21   4.14     .00
   .00   2.55   2.76   2.94   3.08   3.19   3.41   3.71   3.80   3.98   4.14   4.23   4.14     .00
   .00   2.40   2.62   2.77   2.97   3.18   3.41   3.55   3.76   3.93   4.11   4.14   4.14     .00
   .00   2.54   2.81   2.97   3.09   3.13   3.34   3.51   3.67   3.86   4.02   4.09   4.14     .00
   .00   2.93   3.09   3.06   3.14   3.38   3.46   3.61   3.81   3.96   4.14   4.23   4.14     .00
   .00   2.98   3.19   3.33   3.42   3.42   3.52   3.60   3.78   3.98   4.17   4.19   4.14     .00
   .00   2.95   3.23   3.15   3.21   3.44   3.46   3.55   3.76   3.91   4.09   4.11   4.14     .00
   .00   2.98   3.28   3.47   3.48   3.50   3.58   3.62   3.72   3.93   4.14   4.22   4.14     .00
   .00   3.17   3.29   3.31   3.54   3.56   3.65   3.70   3.66   3.79   4.13   4.16   4.14     .00
   .00   3.11   3.51   3.43   3.40   3.53   3.53   3.73   3.73   3.85   3.96   4.16   4.14     .00
   .00   3.97   3.88   3.88   3.88   3.90   3.90   3.90   3.90   3.91   3.99   4.02   4.14     .00
   .00    .00    .00    .00    .00    .00    .00    .00    .00    .00    .00    .00    .00     .00


PEAK PERIOD OVER GRID
    .0     .0     .0     .0     .0     .0     .0     .0     .0     .0     .0     .0     .0      .0
    .0   10.0   10.0   10.0   10.0   10.0   10.0   10.0   10.0   10.0   10.0   10.0   10.0      .0
    .0    9.1    9.1    9.1    9.1   10.0   10.0   10.0   10.0   10.0   10.0   10.0   10.0      .0
    .0    9.1    9.1    9.1    9.1    9.1   10.0   10.0   10.0   10.0   10.0   10.0   10.0      .0
    .0    9.1    9.1    9.1    9.1    9.1   10.0   10.0   10.0   10.0   10.0   10.0   10.0      .0
    .0    9.1    8.3    8.3    8.3    9.1   10.0   10.0   10.0   10.0   10.0   10.0   10.0      .0
    .0    9.1    9.1    8.3    8.3    8.3   10.0   10.0   10.0   10.0   10.0   10.0   10.0      .0
    .0    9.1    9.1    9.1    9.1   10.0   10.0   10.0   10.0   10.0   10.0   10.0   10.0      .0
    .0    9.1    9.1    9.1   10.0   10.0   10.0   10.0   10.0   10.0   10.0   10.0   10.0      .0
    .0    9.1    9.1    9.1   10.0   10.0   10.0   10.0   10.0   10.0   10.0   10.0   10.0      .0
    .0    9.1    9.1   10.0   10.0   10.0   10.0   10.0   10.0   10.0   10.0   10.0   10.0      .0
    .0   10.0   10.0   10.0   10.0   10.0   10.0   10.0   10.0   10.0   10.0   10.0   10.0      .0
    .0   10.0   10.0   10.0   10.0   10.0   10.0   10.0   10.0   10.0   10.0   10.0   10.0      .0
    .0   10.0   10.0   10.0   10.0   10.0   10.0   10.0   10.0   10.0   10.0   10.0   10.0      .0
    .0     .0     .0     .0     .0     .0     .0     .0     .0     .0     .0     .0     .0      .0


MEAN WAVE DIRECTION (X 0.10)
    .0     .0     .0     .0     .0     .0     .0     .0     .0     .0     .0     .0     .0      .0
    .0   16.5   16.4   16.4   16.3   16.3   16.0   16.0   16.0   16.0   16.0   15.9   15.8      .0
    .0   16.6   16.3   16.2   16.3   16.2   16.2   16.1   15.9   15.8   15.7   15.8   15.8      .0
    .0   16.8   16.3   16.1   16.1   16.1   16.0   15.9   15.8   15.8   15.7   15.7   15.8      .0
    .0   16.5   16.2   16.2   16.1   16.1   16.1   16.0   16.0   16.0   15.8   15.8   15.8      .0
    .0   16.2   16.1   16.2   16.1   16.0   16.1   16.0   16.0   15.9   15.8   15.7   15.8      .0
    .0   16.3   16.2   16.3   16.1   16.0   16.0   15.9   15.9   15.7   15.6   15.7   15.8      .0
    .0   16.4   16.1   16.0   16.3   16.2   16.1   16.1   16.0   16.0   15.9   15.9   15.8      .0
    .0   16.2   16.0   16.3   16.2   16.2   16.2   16.1   16.1   16.0   15.9   15.8   15.8      .0
    .0   16.2   15.8   15.8   15.9   16.0   16.1   16.1   16.0   15.9   15.7   15.7   15.8      .0
    .0   16.3   16.0   15.9   16.1   16.0   16.0   16.1   16.1   15.9   15.8   15.8   15.8      .0
    .0   16.1   15.9   16.0   15.9   16.0   15.9   15.9   16.0   16.0   15.9   15.7   15.8      .0
    .0   16.3   15.7   15.8   15.8   15.6   15.9   15.8   16.0   16.0   15.9   15.8   15.8      .0
    .0   16.7   16.3   16.3   16.2   16.2   16.2   16.2   16.2   16.1   15.9   15.8   15.8      .0
    .0     .0     .0     .0     .0     .0     .0     .0     .0     .0     .0     .0     .0      .0
```

Figure 11. Sample of periodic information output over the entire grid

source code listing from the output file.

Two-dimensional spectra (Tape 10)

42. This file contains energy density values (units of m-m-sec/rad) for two-dimensional spectra at each special output location for each specified time increment. In the example shown in Figure 12, the first line is the date/time code and the I,J location of the special output point. This example two-dimensional spectrum has 16 angle bands (columns) beginning with 0 deg and incremented by 22.5 deg. The 14 frequency bands (rows) begin with 0.1 Hz and are incremented by 0.01 Hz. This file is automatically saved as an indirect access file. This file is best displayed or printed using 132 column terminals.

```
      1      5      4
    .00    .00    .00    .00    .00    .00    .00    .00    .00    .00    .00    .00    .00    .00    .00    .00
    .00    .00    .00    .00    .01    .06    .17    .13    .00    .00    .00    .00    .00    .00    .00    .00
    .00    .00    .00    .00    .02    .22    .83   1.22    .75    .11    .00    .00    .00    .00    .00    .00
    .00    .00    .00    .00    .02    .33   1.53   2.42   2.08    .67    .07    .00    .00    .00    .00    .00
    .00    .00    .00    .00    .02    .54   3.29   5.47   5.10   1.62    .15    .00    .00    .00    .00    .00
    .00    .00    .00    .00    .02   1.35   8.15  12.48  10.34   3.04    .24    .01    .00    .00    .00    .00
    .00    .00    .00    .00    .02    .84   4.09   5.56   6.16   1.61    .10    .00    .00    .00    .00    .00
    .00    .00    .00    .00    .01    .58   2.80   3.67   2.01    .58    .03    .00    .00    .00    .00    .00
    .00    .00    .00    .00    .02    .62   2.83   3.74   1.77    .51    .02    .00    .00    .00    .00    .00
    .00    .00    .00    .00    .02    .60   2.53   3.28   1.57    .35    .02    .00    .00    .00    .00    .00
    .00    .00    .00    .00    .03    .56   2.19   2.79   1.38    .30    .01    .00    .00    .00    .00    .00
    .00    .00    .00    .00    .03    .51   1.88   2.37   1.23    .25    .01    .00    .00    .00    .00    .00
    .00    .00    .00    .00    .03    .47   1.68   2.09    .84    .19    .01    .00    .00    .00    .00    .00
    .00    .00    .00    .00    .03    .41   1.40   1.74    .71    .16    .01    .00    .00    .00    .00    .00
      1      5      8
    .00    .00    .00    .00    .00    .00    .00    .00    .00    .00    .00    .00    .00    .00    .00    .00
    .00    .00    .00    .00    .00    .00    .00    .00    .00    .00    .00    .00    .00    .00    .00    .00
    .00    .00    .00    .00    .00    .00    .00    .00    .00    .00    .00    .00    .00    .00    .00    .00
    .00    .00    .00    .00    .04    .28    .86   1.82   1.78    .49    .03    .00    .00    .00    .00    .00
    .00    .00    .00    .00    .02    .51   2.09   4.59   4.55   1.26    .07    .00    .00    .00    .00    .00
    .00    .00    .00    .00    .03   1.20   4.41   8.75   8.90   2.43    .15    .00    .00    .00    .00    .00
    .00    .00    .00    .00    .04    .81   2.45   4.88   5.28   1.30    .08    .00    .00    .00    .00    .00
    .00    .00    .00    .00    .05    .73   2.12   2.24   1.97    .54    .04    .00    .00    .00    .00    .00
    .00    .00    .00    .00    .04    .67   1.80   1.59   1.48    .37    .02    .00    .00    .00    .00    .00
    .00    .00    .00    .00    .03    .53   1.35    .98    .93    .21    .01    .00    .00    .00    .00    .00
    .00    .00    .00    .00    .03    .48   1.05    .63    .49    .10    .00    .00    .00    .00    .00    .00
    .00    .00    .00    .00    .02    .27     52    .28    .15    .03    .00    .00    .00    .00    .00    .00
    .00    .00    .00    .00    .00    .00    .00    .00    .00    .00    .00    .00    .00    .00    .00    .00
    .00    .00    .00    .00    .00    .00    .00    .00    .00    .00    .00    .00    .00    .00    .00    .00
```

Figure 12. Sample two-dimensional spectra output

Statistical Summaries (Tape 11)

43. This file contains one-line summaries of significant wave parameters (e.g. significant wave height, HMO; peak spectral period, TP; and mean direction, TH) for both sea and swell at each special output location for each specified time increment. An example from Duck, North Carolina, is given in Figure 13. All one-line summaries for a given time-step are listed by output location I,J. These sets of lines are repeated in chronological order. Each line also gives the wind speed, WS, and the wind direction, WD, at that grid

```
                ST LOC          TOTAL                 SEA                 SWELL           WIND
      DATE       I   J   HMO     TP     TH    HMO     TP     TH    HMO     TP     TH    WS  WD
             1   5   4   3.2    9.1   159.    2.5    7.8   154.    1.9    9.1   162.   21 155
             1   5   8   2.3    9.1   162.     .6    2.6   155.    2.3    9.1   162.   21 155
             1   5  12   2.2    9.1   165.     .6    2.6   155.    2.2    9.1   165.   21 155
             1   5   4   3.2    9.1   162.    2.7    7.9   156.    1.7    9.1   165.   21 150
             1   5   8   2.9    9.1   163.    1.2    4.3   150.    2.7    9.1   163.   21 150
             1   5  12   2.9    9.1   159.     .7    3.1   150.    2.8    9.1   159.   21 150
             1   5   4   3.5   10.0   159.    2.9    8.1   154.    2.1   10.0   160.   23 130
             1   5   8   3.1    9.1   163.    1.4    4.7   130.    2.8    9.1   163.   23 130
             1   5  12   3.1    9.1   161.     .9    3.5   130.    2.9    9.1   161.   23 130
             1   5   4   3.5   10.0   167.    2.8    8.3   159.    2.1   10.0   171.   25 130
             1   5   8   3.6   10.0   165.    1.7    5.0   130.    3.2   10.0   165.   25 130
             1   5  12   3.7   10.0   164.    1.2    3.9   130.    3.6   10.0   164.   25 130
             1   5   4   4.2   10.0   164.    3.4    8.6   159.    2.6   10.0   166.   28 110
             1   5   8   3.8    9.1   169.    2.0    5.3   131.    3.2    9.1   170.   28 110
             1   5  12   3.7   10.0   168.    1.5    4.3   110.    3.3   10.0   168.   28 110
             1   5   4   4.5   10.0   154.    3.7    8.9   144.    2.6   10.0   158.   32 105
             1   5   8   4.3   10.0   155.    2.3    5.7   119.    3.6   10.0   157.   32 105
             1   5  12   4.2   10.0   153.    1.9    4.8   105.    3.8   10.0   154.   32 105
             1   5   4   4.0   11.1   154.    3.3    9.2   142.    2.2   11.1   161.   25  70
             1   5   8   4.0   11.1   152.    2.0    6.0   104.    3.5   11.1   154.   25  70
             1   5  12   4.5   11.1   147.    1.8    5.2    70.    4.1   11.1   147.   25  70
```

Figure 13. Sample summary file output

point at that time-step. This file is automatically saved as an indirect access file.

<u>One-dimensional spectra (Tape 13)</u>

44. This file contains energy density values (units of m-m-sec) for one-dimensional spectra at each special output location for each specified time increment. In the example given in Figure 14, the first line gives the water depth in meters, the wind speed in knots, and the wind direction (in 5-deg increment bands with band number 1 centered on 0 deg). The second line is the date/time code and the I,J location of the special output point. The next two lines give the energy density of the 14 frequency bands beginning at 0.1 Hz and incremented by 0.01 Hz. This file is automatically saved as an indirect access file.

<u>Boundary output file (Tape 30)</u>

45. This optional file contains two-dimensional spectra at specified time-steps. This output file (after manipulation by another code) becomes the boundary input file (Tape 31) for a smaller nested grid run which also requires another code.

<u>Warm start file (Tape 15)</u>

46. This output file is described in the section on model input files.

```
FOR THIS TEST  D,IUWS,IUDIR =    24.10      21      32
    1   5   4
     .00      .15      1.24     2.80     6.36    13.99     7.22     3.80     3.74     3.29
    2.85     2.47      2.09     1.74
    1   5   8
     .00      .00       .00     2.08     5.15    10.16     5.83     3.02     2.35     1.58
    1.10      .50       .00      .00
    1   5  12
     .00      .00       .00     2.22     5.42    10.12     5.70     2.38     1.70     1.06
     .59      .19       .00      .00
FOR THIS TEST  D,IUWS,IUDIR =    24.10      21      31
    1   5   4
     .00      .30      1.35     2.68     5.02    11.90     8.99     4.40     4.14     3.60
    3.16     2.71      2.29     1.90
    1   5   8
     .00      .00       .00     1.84     4.74    10.35     8.44     4.10     3.74     3.19
    2.82     2.28      1.93     1.37
    1   5  12
     .00      .00       .00     2.24     5.92    11.90     9.66     4.29     3.74     2.99
    2.53     1.85      1.46     1.13
FOR THIS TEST  D,IUWS,IUDIR =    24.10      23      27
    1   5   4
     .00      .43      1.32     4.96    13.15    11.58    10.88     5.06     4.53     3.91
    3.35     2.88      2.42     2.00
    1   5   8
     .00      .00      1.04     3.02     7.20     8.77     9.54     4.40     3.77     3.31
    2.90     2.39      1.86     1.67
    1   5  12
     .00      .00      1.14     3.52     8.19    10.24    11.13     4.69     3.73     3.06
    2.56     1.81      1.51     1.30
```

Figure 14. Sample one-dimensional spectra output

# APPENDIX A: SHALWV CYBERNET EXECUTION

1. This Appendix gives the details of setting up and running the SHALWV model on the Cybernet Computer System. Most of this material is specific to the Cybernet system.

## Job Control Language Files

2. The job control language (JCL) file is a batch-run file that gathers up the necessary input files, sends them off to the Cyber 205 for execution, and finally retrieves and saves the generated output files. The preprocessing JCL (PREPJCL) is shown in Figure A1, production JCL (PRODJCL) is listed in Figure A2, and the preprocess and run JCL (PRPOJCL) is given in Figure A3.

3. In the JCL files listed in Figures A1, A2, and A3, the sequence AF=CERCFIL appears several times. This is a reserved file name in the link-pool that the user must create prior to running the model.

4. Further explanation of the JCL statements can be found in the Cybernet system documentation. Be aware that JCL commands and conventions are occasionally changed, so the example JCL files may be outdated.

```
PREPJCL.
USER(U=xxxxxx,PA=yyyyyy)ADY.
RESOURCE,JCAT=P4,TL=900.
CHARGE,CEROEGC,xyzxyz.
PURGE,PREP.
LINK,GET(CERC=MODEL/FM=KOE,AF=CERCFIL,DD=C6)
LINK,GET(TAPE20=PREPIN/FM=KOE,AF=CERCFIL,DD=C6)
LINK,GET(TAPE25=DUCKL/FM=KOE,AF=CERCFIL,DD=C6)
REQUEST,PREP/9999,RT=W.
FORTRAN,I=CERC,B=CERCB/#50.
LOAD,CERCB,CN=CERCGO/5000,CDF=4000,GRLPALL= .
CERCGO,TAPE33=PREP.
DEFINE,PREP/9999,RT=W.
SUMMARY.
EXIT.
```

Figure A1. Preprocessing JCL (PREPJCL)

```
PRODJCL.
USER(U=xxxxxx,PA=yyyyyy)ADY.
RESOURCE,JCAT=P4,TL=900.
CHARGE,CEROEGC,xyzxyz.
LINK,GET(CERC=MODEL/FM=KOE,AF=CERCFIL,DD=C6)
LINK,GET(TAPE20=PRODIN/FM=KOE,AF=CERCFIL,DD=C6)
LINK,GET(TAPE21=WIND3/FM=KOE,AF=CERCFIL,DD=C6)
ATTACH,PREP.
ATTACH,WARM.
ATTACH,BNDYIN.
FORTRAN,I=CERC,B=CERCB/#50.
REQUEST,TAPE10/1000.
LOAD,CERCB,CN=CERCGO/5000,GRLPALL= ,CDF=4000.
CERCGO,TAPE33=PREP,TAPE15=WARM,TAPE31=BNDYIN.
LINK,REPLACE,TAPE10=TAPE10/FM=KOE,DD=C6,AF=CERCFIL.
LINK,REPLACE,TAPE11=TAPE11/FM=KOE,DD=C6,AF=CERCFIL.
LINK,REPLACE,TAPE13=TAPE13/FM=KOE,DD=C6,AF=CERCFIL.
PURGE,WARM.
SUMMARY.
EXIT.
LINK,REPLACE,TAPE10=TAPE10/FM=KOE,DD=C6,AF=CERCFIL.
LINK,REPLACE,TAPE11=TAPE11/FM=KOE,DD=C6,AF=CERCFIL.
LINK,REPLACE,TAPE13=TAPE13/FM=KOE,DD=C6,AF=CERCFIL.
```

Figure A2. Production JCL (PRODJCL)

```
PRPOJCL.
USER(U=xxxxxx,PA=yyyyyy)ADY.
RESOURCE,JCAT=P4,TL=900.
CHARGE,CEROEGC,xyzxyz.
LINK,GET(CERC=CERC2/FM=KOE,AF=CERCFIL,DD=C6)
LINK,GET(TAPE20=PRPROIN/FM=KOE,AF=CERCFIL,DD=C6)
LINK,GET(TAPE25=DUCKL/FM=KOE,AF=CERCFIL,DD=C6)
LINK,GET(TAPE21=WIND3/FM=KOE,AF=CERCFIL,DD=C6)
FORTRAN,I=CERC,B=CERCB/#50.
LOAD,CERCB,CN=CERCGO/#5000,CDF=4000,GRLPALL= .
CERCGO.
LINK,REPLACE,TAPE10=TAPE10/FM=KOE,DD=C6,AF=CERCFIL.
LINK,REPLACE,TAPE11=TAPE11/FM=KOE,DD=C6,AF=CERCFIL.
LINK,REPLACE,TAPE13=TAPE13/FM=KOE,DD=C6,AF=CERCFIL.
SUMMARY.
EXIT.
LINK,REPLACE,TAPE10=TAPE10/FM=KOE,DD=C6,AF=CERCFIL.
LINK,REPLACE,TAPE11=TAPE11/FM=KOE,DD=C6,AF=CERCFIL.
LINK,REPLACE,TAPE13=TAPE13/FM=KOE,DD=C6,AF=CERCFIL.
```

Figure A3. Preprocess and run JCL (PRPOJCL)

## Executing a JCL File

5. To interactively run this batch job, issue the following commands from the terminal.

```
GET,JCLFILE
SUBMIT,JCLFILE,T
```

```
Example:  GET,PREPJCL
          SUBMIT,PREPJCL,T
```

To check on the status of the job from an interactive terminal, type:

```
LINK,ENQUIRE
```

When the job is available for output to the terminal, a seven-character job name will be displayed by the LINK,ENQUIRE command (example: AF5B6B2). To bring the output file to the terminal, type

QGET,xyz    where xyz are the last three characters of the filename.

```
Example:  QGET,6B2
```

This command retrieves the output file and makes it local. Now it can be made an indirect access file with the interactive command

```
REPLACE, AF5B6B2=myfile      (for example)
```

or it can be placed into the editor for examination

```
XEDIT,AF5B6B2                (for example)
```

6. The primary output data files are automatically saved as indirect access files. And each time the job is run, the new output files will overwrite the old files unless the old files are renamed.

END

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DTIC