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US Army Corps
of Engineers

The Hydrologic
Engineering Center

GENERALIZED COMPUTER PROGRAM

HEC-1

Flood Hydrograph Package

Computer Implementation Guide

July 1985

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U.S. Army Corps of Engineers
Water Resources Support Center

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TABLE OF CONTENTS

COMPUTER IMPLEMENTATION GUIDE FOR HEC-1

1.0 INTRODUCTION

1.1 Purpose of Document

This guide provides information about the implementation, organization and structure of the source code for the HEC-1 Flood Hydrograph Package, 1981.* It is intended for use by systems engineers and engineering programmers who are implementing the program on a mainframe computer system or modifying the source code to meet special needs of their users and/or computer system.

Some of the information in this Implementation Guide will be useful to persons modifying the microcomputer (PC) version of HEC-1. Separate documents are available for installation of the PC executable code, "Microcomputer Version of HEC-1 Flood Hydrograph Package," and for use of the PC source code, "Source Code Comments: HEC-1 Microcomputer Version."

1.2 Supplementary Programs

A program to convert old input data (1973 version) into the current input data format (1981 version) is available. Corps users may interface HEC-1 input and output with the HEC Data Storage System. These programs are described in the Program Implementation section that follows.

1.3 Notification of Errors and Modifications

All holders and users of the HEC-1 program will be notified of errors in or modifications to the program. The HEC maintains an address file of persons who have obtained the program from HEC as well as those people who use the program on a computer service and have made official arrangements with the HEC to be placed on the HEC-1 mailing list.

Users of the program should notify the HEC about any errors they find in the program. The HEC also welcomes any suggestions for improvement of the program source code, operating mode and technical capabilities. Any information regarding problems with the use of the program on different computers will be greatly appreciated.

2.0 PROGRAM IMPLEMENTATION

2.1 Using the HEC-Supplied Magnetic Tape

The HEC distributes program source code for mainframe computers on a 1/2" magnetic tape written according to the requester's specifications (for a PC, a 5-1/4" floppy disk). A description of the tape contents is provided with the tape. The files on the tape are: source code, test data, input data description, and a data conversion program.

*HEC-1 Flood Hydrograph Package, Users Manual, U.S. Army Corps of Engineers, Davis, California, September 1981, Revised January 1985.

The source code should be copied from the tape into the user's program library. The source code has standard FORTRAN 77 headings for the main routine and subroutines. Some editing of the source code may be necessary as described in the next section on machine-dependent Code and Memory Storage Requirements. The Input Data Conversion Program is a separate program and should be compiled separately from the HEC-1 source code.

2.2 Input/Output File Structure

HEC-1 uses up to 14 input/output and scratch files. These can be stored on disk, tape, or whatever medium is available. The unit numbers assigned to the HEC-1 files are shown in Table 1. These numbers can be changed for a particular installation by changing their definition in BLOCK DATA. Table II describes the execution time file assignments for several systems.

2.3 Machine-Dependent Code

Two items in the source code are unique to various computer systems as shown in Table III. The first item is necessary when using FORTRAN 77. The OPEN statement shown specifies that a blank in the HEC-1 input data is read as a zero. The second item is a system-related feature used in subroutine BANNER to obtain the date and time for a particular program execution. The subroutines DATE and TIME shown are examples of this feature on a CDC Cyber 865 computer system.

2.4 Compilation and Execution Requirements

HEC-1 requires a Fortran 77 compiler and up to 14 input/output files. The computer memory requirements, compilation time and example problems' execution times are given in the HEC-1 Users Manual (Section 13, Table 13.2). The HEC would appreciate information about memory requirements and execution times on other computers.

2.5 Program Operation Verification

The correct operation of HEC-1 should be verified using the HEC-supplied test data. The test data corresponds to the example problems provided in Section 12 of the HEC-1 Users Manual. The results reported for the first 11 test examples should be reproduced exactly, with minor exceptions due to word size. Test example 12 is more sensitive to word size. Comparison with the reported results should be within five percent. The reported results were produced on the Harris 500 computer using a 39-bit mantissa for real numbers.

2.6 Input Data Conversion Program

The Input Data Conversion program provided on the tape converts old HEC-1 (1973) data sets into the equivalent data sets required by the new (1981) program. The conversion program does not recognize the special records used in the old dam-break, kinematic-wave and system-optimization versions of HEC-1. Input to the conversion program is the old data set (A, B, etc., records) and the new data set is output as a scratch file for disposal to the card punch, permanent file and/or printer. The conversion program has not been extensively tested but should suffice to make the majority of the changes necessary to use the new program. Users are encouraged to make the conversion and then discard the old data deck. The conversion program is not intended to be a preprocessor to the new program.

Table I

Input/Output and Scratch Files

Unit Number	Variable Name	Description	Formatted, F Unformatted, U	Max Record Length
5	INP	Primary input	F	80 characters
6	IP	Primary output file (printer)	F	132 characters
7	IPU	Punch	F	80 characters
23	IC	Working input file; reformatted input data with line number and next record ID appended to front of each record	F	89 characters
24	IS*	Dam-overtopping summary report	F	132 characters
25	IU*	Runoff parameter optimization	F	132 characters
32	IDIV	Scratch, saves diversion hydrographs	U	4895 real + 3 integer words
33	IE	Scratch; expected annual damage summary data	U	50 real + 6 integer words
34	IR	Scratch; data for first plan in multiplan run	U	61 real words
35	ISOP	Scratch; data for flood control system optimization	U	2400 real words
36	LSFIL	Scratch; data for user-defined output tables	U	301 real words
38	ND	Scratch; output summary data	U	91 real + 4 integer words
**	IOUT	Output data; used to save hydrographs for a subsequent job	F	131 characters
**	IQIN	Input data; hydrographs from a previous job	F	131 characters

* File is copied to primary output file (IP) by subroutine PRT

** Unit number is defined by user on KO or BI records (The unit numbers specified should not conflict with other file definitions, for example, 21 and 22 are possible choices).

Table II

Input/Output File Specifications for Alternative Computer Systems

---

Table IIa. File Assignments for Using HEC-1 on an IBM 370

```
//HEC1N     PROC  PROGRAM=HEC1N,REG=512K,LIB=TESTLIB
//HEC1N     EXEC  PGM=&PROGRAM,REGION=&REG
//STEPLIB    DD   DSN=WATER.&LIB,DISP=SHR
//FT01F001   DD   DDNAME=SYSIN
//FT02F001   DD   SYSOUT=B
//FT03F001   DD   SYSOUT=A,DCB=(LRECL=133,RECFM=FA,BLKSIZE=133)
//FT10F001   DD   UNIT=DISK,DCB=(RECFM=FB,LRECL=89,BLKSIZE=3916),
//                SPACE=(CYL,(2,1))
//FT11F001   DD   UNIT=DISK,SPACE=(CYL,(1,1)),DCB=RECFM=VBS
//FT12F001   DD   UNIT=DISK,SPACE=(CYL,(1,1)),DCB=RECFM=VBS
//FT14F001   DD   UNIT=DISK,SPACE=(CYL,(1,1)),DCB=RECFM=VBS
//FT16F001   DD   UNIT=DISK,SPACE=(TRK,(10,1)),
                  DCB=(RECFM=FB,LRECL=132,BLKSIZE=3960)
//FT17F001   DD   UNIT=DISK,SPACE=(CYL,(1,1)),DCB=RECFM=VBS
//FT18F001   DD   UNIT=DISK,SPACE=(CYL,(1,1)),DCB=RECFM=VBS
//FT19F001   DD   UNIT=DISK,SPACE=(TRK,(10,1)),
                  DCB=(RECFM=FB,LRECL=132,BLKSIZE=3960)
//FT20F001   DD   UNIT=DISK,SPACE=(CYL,(1,1)),DCB=RECFM=VBS
```

UNIT (FILE) NUMBERS ARE IMPLEMENTATION DEPENDENT AND WILL VARY BETWEEN SITES. FOR THIS EXAMPLE THE UNIT NUMBERS AS ASSIGNED IN BLOCK DATA ARE:

INP	IP	IPU	IC	IS	IU	IDIV	IE	IR	ISOP	LSFIL	ND
1	3	2	10	16	19	11	18	17	20	14	12

Table II.b File Assignments for Using HEC-1 on a Burroughs B6700

```
FILE  5(KIND=DISK,FILETYPE=7,TITLE="D/HEC1")
FILE  6=FILE6,UNIT=PRINTER,RECORD=22
FILE  7=FILE7,UNIT=PRINTER,RECORD=22
FILE  11=FILE11,UNIT=DISK,RECORD=22,BLOCKING=30
FILE  12=FILE12,UNIT=DISK,RECORD=22,BLOCKING=30,AREA=120*500
FILE  23=FILE23,UNIT=DISK,RECORD=15,BLOCKING=30,AREA=120*500
FILE  24=FILE24,UNIT=DISK,RECORD=22,BLOCKING=30,AREA=120*500
FILE  25=FILE25,UNIT=DISK,RECORD=22,BLOCKING=30,AREA=120*500
FILE  32=FILE32,UNIT=DISK,RECORD=4895,AREA=1*1000
FILE  33=FILE33,UNIT=DISK,RECORD=60,BLOCKING=30,AREA=120*500
FILE  34=FILE34,UNIT=DISK,RECORD=90,BLOCKING=30,AREA=120*500
FILE  35=FILE35,UNIT=DISK,RECORD=2400,AREA=1*1000
FILE  36=FILE36,UNIT=DISK,RECORD=330,BLOCKING=6,AREA=120*500
FILE  38=FILE38,UNIT=DISK,RECORD=120,BLOCKING=30,AREA=120*500
```

Table IIc. File Assignment for Using HEC-1 on a CDC

Place the following lines as the first record of FORTRAN program source code:

```
   PROGRAM HEC1 (INPUT,OUTPUT,PUNCH,TAPE5=INPUT,
1  TAPE6=OUTPUT,TAPE7=PUNCH,TAPE21,TAPE22,TAPE23,TAPE24,
2  TAPE25,TAPE32,TAPE33,TAPE34,TAPE35,TAPE36,
3  TAPE38)
```

See Table I for unit numbers corresponding to TAPE5 through TAPE38. For example, TAPE5 corresponds to unit number 5, variable INP, and TAPE38 corresponds to unit number 38, variable ND.

Table IId. File Assignments for Using HEC-1 on a Harris 500

AS 5 = Input File	formatted file
AS 6 = Output File	"
AS 7 = Punch File	"
AS 23 = W1	formatted work file
AS 24 = W2	"
AS 25 = W3	"
AS 32 = U2	unformatted work file
AS 33 = U3	"
AS 34 = U4	"
AS 35 = U5	"
AS 36 = U6	"
AS 38 = U8	"

Table III

Machine-Dependent Code

```
      PROGRAM HEC1

C ======================================================================1147002
C         USE FOLLOWING STATEMENT IF PROGRAM IS COMPILED USING          1147102
C         A FORTRAN 77 COMPILER.                                        1147202
C                                                                       1147302
      OPEN (IC,BLANK='ZERO')                                            1147402
C                                                                       1147502
C ======================================================================1147602


      SUBROUTINE BANNER

C                                                                       1480
C        MACHINE SPECIFIC CALL TO DATE AND TIME ROUTINES                1481
C                                                                       1482
      CALL DATE (I1)                                                    1483
      CALL TIME (I2)                                                    1484
```

2.7 Data Storage System - DSS

The HEC Data Storage System is not currently available for general distribution. Consequently, an HEC-1 dummy routine, DSMSTR, is used in place of the routines available to Corps users for accessing DSS. Absence of these routines or the presence of the dummy DSMSTR does not have any computational effect on program execution.

3.0 ERROR MESSAGES

The HEC-1 Users Manual (Section 11, Table 11.1) lists error messages which will print, along with an explanation of the message. Some errors will not cause the program to stop execution, so the user should always check the output for possible errors or warnings. The array dimensions listed in Table IV are those used by HEC on a CDC Cyber 865 computer, and correspond to the official HEC-distributed version of the program. Other dimensions may be used as noted in the following section on Memory Management. If the dimensions are changed, the dimension-error checks should also be changed in the source code.

The computer operating system may also print error messages. When an error occurs, the user should first ascertain if it is generated by HEC-1 or by the system. If it is generated by HEC-1, i.e., in the format given in the Users Manual, that table should be referred to and the indicated actions taken. If the error is system generated, the computer center user service and/or the in-house computer systems personnel should be contacted to ascertain the meaning of the error. These errors may be due to incorrectly input or read data, errors in HEC-1, or the computer system. If these system errors cannot be resolved in-house or if there appears to be an error in the HEC-1 program, the HEC should be contacted.

4.0 COMPUTER MEMORY MANAGEMENT

4.1 Changing Dimensions

Computer memory requirements can be reduced by decreasing the dimensions of some arrays. Table IV identifies the arrays whose dimensions have the most impact on core storage. Because of the error checks on dimensions (see previous section) and for ease of making changes, the dimensions are specified as variables.

To change a dimension, both the dimension-size variable and the arrays themselves must be changed. Table IV shows both the dimension-size variables and the arrays in which the particular dimension occurs. The labeled common block or subroutines in which the array occurs is also identified. Note that many of the dimensions are a function of other dimension statements. The amount of reduction in a dimension will be dependent upon the options and the sizes desired by the user.

Pay special attention to arrays which occur in EQUIVALENCE statements.

4.2 Deleting Subroutines

Computer memory requirements can also be reduced by eliminating some subroutines. The subroutines required for various HEC-1 simulation options are shown in Table V. The memory reduction obtained from deleting subroutines may not be significant if an overlay is used.

Table IV

Array Dimensions

Variable	Name/Definition	Array Size Limit	Arrays	Location
KQ	Hydrograph ordinates	300	DEWPT,EXCSR,EXCSS,ITLS KDAY,KHOUR,KMON,PRCP, PRCPR,Q,QO,RAINA,SNMT, SOL,STG,STR,TMPR,WIND	COMMON/ORDTS/
KR	Recording precip gages	15	PRCPR	COMMON/ORDTS/
			ISTAR	COMMON/PRECIP/
KQH[1]	PLAN/RATIO hydrograph ordinates	4800	QH,QK	COMMON/MULTQ/
KUHGQ	Unit graph ordinates	150	QUNGR,QCLK	COMMON/UNITGR/
KN	Non-recording gages	70	ANAPN,ISTAN	COMMON/PRECP/
KHN	Non-recording gage weighting	10	ISTN,WTN	COMMON/PRECP/
KHR	Recording gage weighting	5	ISTR,WTR	COMMON/PRECP/
KZONE	Snowmelt zones	10	ANAP,ANDAY,AREA,CUML, SNO,SNOW	COMMON/SNOWZ/
KSTM	Depth-area precip array	9	AX,BX,CX,DX,STRM,TRDA	COMMON/MULTPS/
KRTIO	Flood/precip RATIOS	9	RTIO	COMMON/MULTPS/
			FREQ,PFRQ	COMMON/ECON2/
			QPREP	SUBROUTINE ECONO
LCM[2]	Internal Random Access Array	24025	SAVE	COMMON/RAND/

[1]KQH should be the lesser of 2•KRTIO•KQ or 4800

[2]LCM = 5•(KQH+5)

4.3 Overlaying Subroutines

Computer memory requirements can also be reduced by overlaying subroutines. A suggested overlay structure is given in Table VI. That overlay structure was successfully used to implement the program on a Harris 100 computer with 64k (decimal) words of central memory.

The overlay structure details which subroutines must be in memory at the same time during execution by a root path. The path is described by the letter code given in Table VI. For example, the MAIN ROOT connects with high level sub-roots A, B, C, D, E, F, G, or H. The sub-roots connect with lower level roots. For example, sub-root B connects with B1, B2, B3, B4, or B5. This root heirarchy may be continued to lower sub-root levels. For example, a root path may consist of F, F3, F3B and either F3B1, F3B2, F3B3, F3B4, or F3B5. All the subroutines that are part of any root path must be in memory at the same time.

5.0 PROGRAM STRUCTURE

The HEC-1 computer program consists of a main routine and 67 subroutines. The interlinkage of the subroutines is shown in Figure 1. A brief description of each subroutine is given in Table VII.

Table V

Required Subroutines for HEC-1 Simulation Options

Simulation options

1 All jobs
2 Runoff parameter optimization
3 Routing parameter optimization
4 Stream network
5 Multiplan-multiratio
6 Economics
7 System optimization
8 Stream network with dam break
9 Stream nework with kinematic wave
10 Stream network with DSS
11 Economic model with DSS

X required subroutines
* subroutine occasionally used, depends on input option
† subroutines needed for DSS (Corps users only)

Subroutine	1	2	3	4	5	6	7	8	9	10	11
HEC1	X	X	X	X	X	X	X	X	X	X	X
ADDTIM	X	X	X	X	X	X	X	X	X	X	X
ADJUST				*	*	*	*	*	*	*	*
AKIMA						X	X				X
AKIMAI						X	X				X
BALNC				*							
BANNER	X	X	X	X	X	X	X	X	X	X	X
BASIN		X		X	X	X	X	X	X	X	X
BIT	X	X	X	X	X	X	X	X	X	X	X
CHNPRC				*	*	*	*	*	*	*	*
CKPRNM†										X	X
COPYIN	X	X	X	X	X	X	X	X	X	X	X
COST							X				
DAMAGE						X	X				X
DAMBRK								X			
DATES	X	X	X	X	X	X	X	X	X	X	X
DIVERT				X	X	X	X	X	X	X	X
DSMSTR	X	X	X	X	X	X	X	X	X	X	X
EADSUM						X	X				X
EAV						X	X				X
ECONO						X	X				X
EQUATN				*	*	*	X	X	*	*	*
EREXIT	X	X	X	X	X	X	X	X	X	X	X
FDKRUT									X		
FDKSRM									X		
FLOGRD									X		
FRMMTC									X		
GETDTA							X				
GRAPH	X	X	X	X	X	X	X	X	X	X	X
HYDLMT				*	*	*	*	X	*	*	*

Table V (Continued)

Simulation options

1 All jobs
2 Runoff parameter optimization
3 Routing parameter optimization
4 Stream network
5 Multiplan-multiratio
6 Economics
7 System optimization
8 Stream network with dam break
9 Stream nework with kinematic wave
10 Stream network with DSS
11 Economic model with DSS

X required subroutines
* subroutine occasionally used, depends on input option
† subroutines needed for DSS (Corps users only)

Subroutine	Options 1	2	3	4	5	6	7	8	9	10	11
IDTC	X	X	X	X	X	X	X	X	X	X	X
INPUT	X	X	X	X	X	X	X	X	X	X	X
INTPL	X	X	X	X	X	X	X	X	X	X	X
INTPLQ				*	*	*	*	*	*	*	*
INVAR		X	X								
KINOFF									X		
LOCALQ				*					*	*	
LOCAT				*	*	*	*	*	*	*	*
LOGLOG				*	*	*	*	*	*	*	*
LPDMG							X				
LTR	X	X	X	X	X	X	X	X	X	X	X
MANE2		X		X	X	X	X	X	X	X	X
MISDTA				*					*	X	X
OPSTAT		X									
OPTIM		X	X				X				
OUTPUT	X	X	X	X	X	X	X	X	X	X	X
OUTSUM				X	X	X	X	X	X	X	X
PLNSET					X	X	X	X			X
PMPSAV				*	*	*	X	*	*	*	*
PREVU				X	X	X	X	X	X	X	X
PRNTQ	X	X	X	X	X	X	X	X	X	X	X
PRT		X					X	X			
PUMP				*	*	*	X	*	*	*	*
PSUMRY				*	*	*	X	*	*	*	*
QG3						X	X				X
RDHDPR†										X	X
RDTIMS†										X	X
RDZWEC†											X
RDZWTS†										X	X
READBZ†										X	X
READQ				*	*	*	*	*	*	*	*
READZR†										X	X
RECESN		X		X	X	X	X	X	X	X	X

Table V (Continued)

Simulation options

1 All jobs
2 Runoff parameter optimization
3 Routing parameter optimization
4 Stream network
5 Multiplan-multiratio
6 Economics
7 System optimization
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10 Stream network with DSS
11 Economic model with DSS

X required subroutines
* subroutine occasionally used, depends on input option
† subroutines needed for DSS (Corps users only)

	Options										
Subroutine	1	2	3	4	5	6	7	8	9	10	11
REDARY	X	X	X	X	X	X	X	X	X	X	X
RESOUT				X	X	X	X	X	X	X	X
RESQ				*	*	*	X	X	*	*	*
RESVRT				*	*	*	X	X	*	*	*
ROFGRD									X		
ROUTE			X	X	X	X	X	X	X	X	X
RUNOF		X		X	X	X	X	X	X	X	X
SAVDTA							X				
SETBIT	X	X	X	X	X	X	X	X	X	X	X
SETOPT							X				
SOLVEQ				*	*	*	X	X	*	*	*
SPIRAT				*	*	*	*	*	*	*	*
STACK				X	X	X	X	X	X	X	X
STAGE				*	*			*	*	*	*
STFN				*	*	*	X	X	*	*	*
STORAG				*	*	*	X	X	*	*	*
STOUT				*	*	*	*	X	*	*	*
STPRTC†										X	X
SUMOP		X									
SUMRY	X	X	X	X	X	X	X	X	X	X	X
SYSOPT							X				
TCOMPR	X	X	X	X	X	X	X	X	X	X	X
TIMAVG	X	X	X	X	X	X	X	X	X	X	X
TIMEIN	X	X	X	X	X	X	X	X	X	X	X
TOMTRC									X		
TP40				*	*	*	*	*	*	*	*
TSUB	X	X	X	X	X	X	X	X	X	X	X
TX2IN	X	X	X	X	X	X	X	X	X	X	X
USRDO				*	*			*	*	*	*
WRITQ				*	*			*	*	*	*
WRTQDS†										X	X
WRTQFR†											X
ZERO	X	X	X	X	X	X	X	X	X	X	X
ZRTYPE†										X	X

Table VI
Overlay Structure

```
=====================================================================
|Main Root| (A) BANNER   COPYIN   PREVU   PRT    ZERO  |
| HEC1    |=========================================================
| DSMSTR  | (B)    | (B1) DATES    ADDTIM  |
| EREXIT  | BIT    |=======================
| OPTIM   | IDTC   | (B2) TIMEIN   TX2IN   |
| SAVDTA  | INPUT  |================================================
| SETOPT  | LTR    | (B3) ADJUST   BASIN   LOCAT    LOGLOG   TP40   |
| SYSOPT  | REDARY |================================================
| USRDO   | SERBIT | (B4) INTPLQ   PRNTQ   READQ    SUMRY    TIMAVG |
|         | TCOMPR |================================================
|         | TSUB   | (B5) MISDTA   CKPRNM  RDHDPR   RDTIMS   RDZWTS |
|         |        |      READBZ   READZR  STPRTC   ZRTYPE          |
|         |=========================================================
|         | (C) BIT      OUTPUT |
|         |=========================================================
|         |     BIT      RESOUT     DAMBRK | D1 HYDLMT   STOUT |
|         | (D) COST     RESQ       GRAPH  |===================
|         |     INTPL    STORAG            | D2 SPIRAT |
|         |=========================================================
|         | (E) BALNC    PRNTQ    STACK    SUMRY    TIMAVG |
|         |=========================================================
|         |        |      DIVERT   COST     INTPLQ   GRAPH |
|         |        | (F1) LOCALQ   MISDTA   OUTSUM         |
|         |        |      SUMRY    TIMAVG   WRITQ          |
|         |        |==========================================
|         |        |          | [F2A] COST  |
|         |        | (F2)     |=======================
|         |        | BIT      | [F2B] FDKRUT   FDKSRM |
|         |  (F)   | ROUTE    |==========================================================
|         |        |          | [F2C] DAMBRK   PUMP     RESQ   RESVRT   PMPSAV   PSUMRY |
|         |        |          |       SOLVEQ   EQUATN   STFN   STORAG   TIMAVG   OUTSUM |
|         |        |=====================================================================
|         | INTPL  |          | [F3A] INVAR    OPSTAT   SUMOP |
|         | MANE2  | (F3)     |================================
|         | PRNTQ  |          |          | [F3B1] FRMMTC |
|         | STACK  | RECESN   |          |================
|         |        | RUNOF    |  [F3B]   | [F3B2] FLOGRD |
|         |        |          |          |================
|         |        |          | KINOFF   | [F3B3] ROFGRD |
|         |        |          |          |================
|         |        |          |          | [F3B4] TOMTRC |
|         |        |          |          |================
|         |        |          |          | [F3B5] FDKRUT |
|         |        |================================================
|         |        | (F4) BASIN   ADJUST   LOCAT    LOGLOG   TP40 |
|         |        |================================================
|         |        | (F5) STAGE  |
|         |        |==============
|         |        | (F6) PLNSET |
|         |        |====================
|         |        | (F7) BIT      WRTQDS |
|         |        |====================
|         |        | (F8) GRAPH  |
|         |=============================================================
|         | (G) AKIMA   AKIMAI   BIT     COST   DAMAGE   EADSUM   EAV    |
|         |     ECONO   INTPL    LPDMG   QG3    SETBIT   RDZWEC   WRTQFR |
|         |=============================================================
|         | (H) GETDTA |
=====================
```

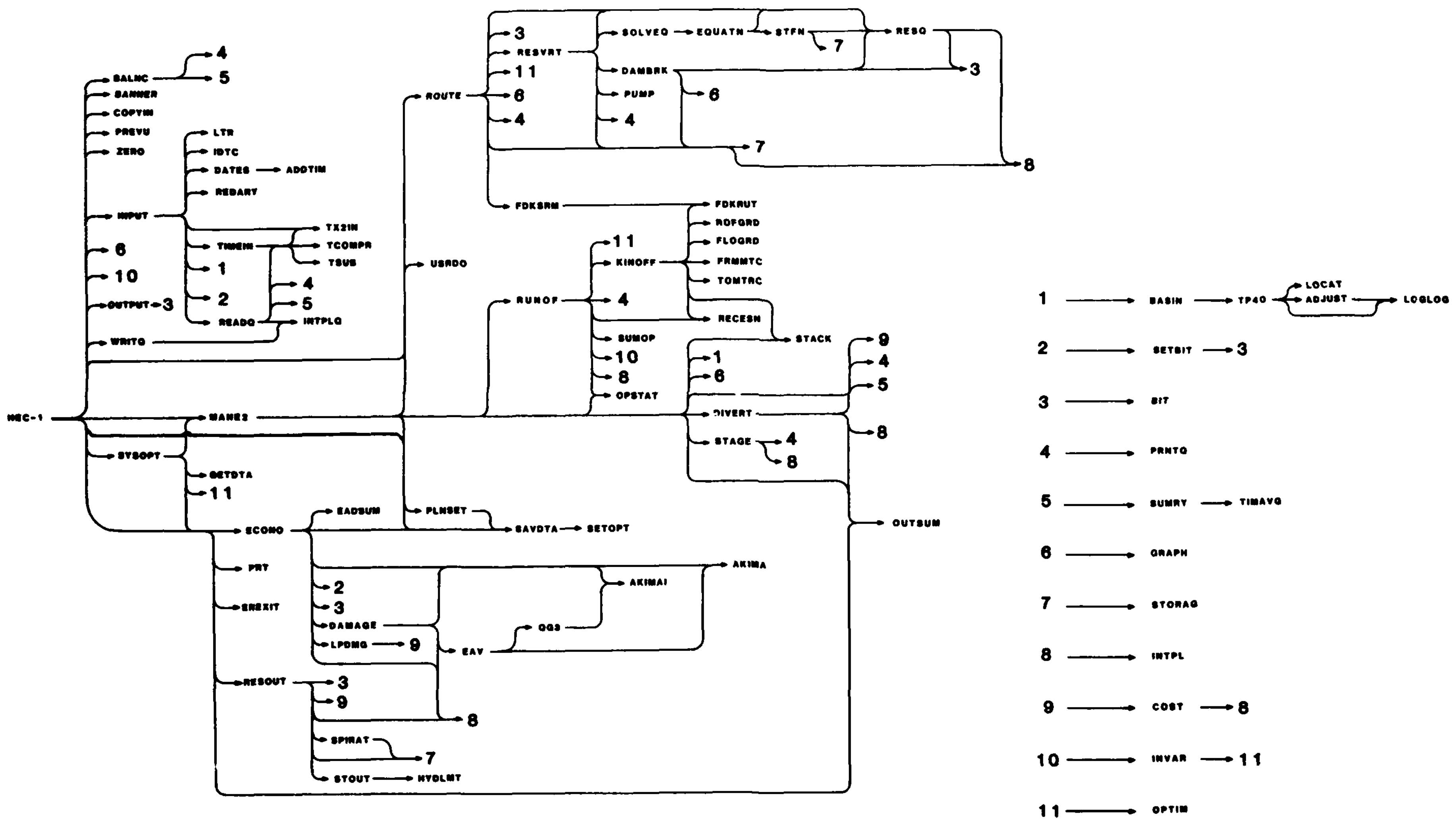

Figure 1 INTERCONNECTION OF HEC-1 ROUTINES

Table VII

Description of HEC-1 Subroutines

HEC1	- initialization, control program flow
ADDTIM	- adds one-time interval to current time
ADJUST	- computes depth-area adjustment for hypothetical storm
AKIMA	- finds coefficients for cubic spline
AKIMAI	- cubic spline interpolation
BALNC	- computes balanced hydrograph
BANNER	- prints program banner
BASIN	- computes basin-average rainfall; standard project storm; probable maximum storm; weighting of gaged rainfall
BIT	- tests a bit in an integer variable
CHNPRC	- computes channel loss
CKPRNM	- checks parameter name for DSS variables against known parameters
COPYIN	- copies input data to working file; adds identification of next record to beginning of each record; converts data from free format to fixed format
COST	- computes cost of a project element
DAMAGE	- computes damage-frequency relation
DAMBRK	- computes dam-breach size; sets time step for breach calculation; prints dam-break summary
DATES	- computes date and time for each hydrograph ordinate
DIVERT	- diverts flows; retrieves diversion hydrographs
DSMSTR	- controls use of DSS
EADSUM	- prints summary of expected annual damages
EAV	- computes expected annual damage
ECONO	- reads data for expected annual damage calculation
EQUATN	- equations which require iterative solution
EREXIT	- prints number of errors; exits program on error

Table VII (Continued)

FDKRUT - finite difference solution of kinematic wave routing

FDKSRM - routes flows using kinematic wave method

FLOGRD - computes distance step for kinematic wave routing of runoff hydrograph in collector and main channels

FRMMTC - converts excess from metric to English units

GETDTA - gets data to compute plan 2 for flood-contol system optimization

GRAPH - makes printer plots of hydrographs

HYDLMT - computes hydraulic characteristics from cross-section data

IDTC - compares next record identification code with current record identification code

INPUT - reads input data from working file

INTPL - linear interpolation

INTPLQ - interpolates a hydrograph from one interval to another

INVAR - initializes variables for runoff parameter or routing parameter optimization

KINOFF - transforms rainfall excess to runoff using kinematic wave

LOCALQ - computes local flow hydrograph

LOCAT - generates position in triangular distribution for hypothetical storm

LOGLOG - log-log interpolation

LPDMG - computes flow/stage-damage relation for current local protection level

LTR - finds position of record identification code in array of valid letters

MANE2 - directs program to desired operation; combines hydrographs

MISDTA - tests a variable for a value indicating missing data

OPSTAT - computes statistics for comparing two hydrographs

OPTIM - controls variation of parameters being optimized

OUTPUT - prints input data

OUTSUM - prints final hydrograph summary

PLNSET - sets variable for computing remaining plans after all input data has been read for a station

Table VII (Continued)

PMPSAV - saves pumpflow hydrographs

PREVU - prints schematic diagram of stream system; sets up table for user-defined output

PRNTQ - prints hydrographs

PRT - copies summary table produced by subroutines DAMBRK and SUMOP from scratch files to printer

PSUMRY - saves pumpflow values for summary printout

PUMP - computes pump flow

QG3 - three point gaussian quadrature

RDHDPR - reads HYDPAR data from DSS

RDTIMS - reads time series data from DSS

RDZWEC - reads ZW record for flow-frequency data

RDZWTS - reads ZW record for hydrologic time series

READBZ - reads BZ record

READQ - reads a hydrograph from a file

READZR - reads ZR record

RECESN - adds base flow to direct runoff hydrograph

REDARY - reads table data (elevation, flow, storage, etc.)

RESOUT - computes spillway flow from weir coefficients; computes storage-outflow table from storage-elevation and outflow-elevation tables

RESQ - computes flow from reservoir for given elevation

RESVRT - routes flow through reservoir using level-pool routing

ROFGRD - computes time and distance step size for kinematic wave routing of rainfall excess

ROUTE - routes flows using Muskingum, modified Puls, or straddle-stagger methods; optimizes Muskingum K and X

RUNOF - computes unit hydrograph; precipitation excess; transforms excess to direct runoff

SAVDTA - saves data for computing plan 2 for flood-control system optimization

SETBIT - sets a bit in an integer variable

Table VII (Continued)

SETOPT - sets variable to be optimized

SOLVEQ - iterative solution algorithm using combination of secant method and interval halving

SPIRAT - computes flow from ogee spillway

STACK - stores and retrieves hydrographs

STAGE - converts flows to stages

STFN - computes change in storage plus inflow minus outflow (continuity) for given elevation for reservoir routing

STORAG - computes reservoir storage from surface area and elevation data

STOUT - computes storage-outflow-elevation table for modified Puls routing from eight-point cross-section

STPRTC - sets part C of DSS pathname; saves parameter name

SUMOP - prints summary of runoff parameter optimization

SUMRY - computes summary of a hydrograph computation

SYSOPT - controls optimization of flood-control system components

TCOMPR - compares two times in internal form

TIMAVG - computes average values for a time series

TIMEIN - reads time series data; interpolates to computation interval

TOMTRC - converts runoff hydrograph from English to metric units

TP40 - computes rainfall distribution for hypothetical storm

TSUB - subtracts two times in internal form

TX2IN - converts external time (day, month, year, hour) to internal time (year, day, minute)

USRDO - prints user-defined output tables

WRITQ - writes a hydrograph to a file

WRTQDS - writes a hydrograph to DSS

WRTQFR - writes flow-frequency data to DSS

ZERO - initializes variables for a new job

ZRTYPE - gets replacement record type from a ZR record