

Appendix B

HEC-DSS use in HEC-5

HEC-5 can read and write time-series data by using the HEC Data Storage System (HEC-DSS). This Data Storage System (HEC-DSS) provides a convenient file system to transfer data from one application to another application. For example, the Flood Hydrograph Package HEC-1 could be used to develop flood hydrographs which are read by HEC-5 for reservoir system modeling. By using HEC-DSS, flow data required for simulation can be easily defined in HEC-5 by referring to the appropriate data records in the HEC-DSS file. Likewise, HEC-5 results can be stored to HEC-DSS for subsequent analysis using various HEC-DSS utility programs. This approach provides for convenient management and use of model data.

The following sections provide a brief overview of the HEC-DSS, the supporting utility programs, and the HEC-5 application. The HEC-DSS programs are documented in *HEC-DSS User's Guide and Utility Manuals* (HEC, 1994).

B.1 Introduction to the HEC-DSS

The Data Storage System (HEC-DSS) is a data base system developed by the HEC for storing hydrologic data. It consists of a set of FORTRAN subroutines that begin with the letter "Z" (e.g., ZOPEN opens a HEC-DSS file). The subroutines make it easy to add the HEC-DSS capability to a FORTRAN program that would read or write information to a HEC-DSS file. This facilitates adding the capability to a program and sharing of data among different computer programs. The library is documented in *HECLIB, Volume 2: HEC-DSS Subroutines, Programmer's Manual* (HEC, 1991).

A HEC-DSS file is a "Direct Access" (or Random) file. This allows the HEC-DSS software to access any part of the file directly, without having to read through the top of it as in a "Sequential" (normal) file. HEC-DSS files can be named like any other file, except on the DOS PC they usually have an extension of ".DSS".

The HEC-DSS stores sets, or "blocks", of data (referred to as records), each identified by a unique name, or "pathname". The HEC-DSS software uses this pathname to determine where in the HEC-DSS file its corresponding data is located. Each record consists of a header, which describes certain data attributes (such as the data units), and the actual data (which is stored as real numbers).

The HEC-DSS package includes a set of utility programs that use or manipulate data in a HEC-DSS file. The utility programs provide data management functions, graphical and tabular displays.

B.1.1 HEC-DSS Conventions

Conventions have been adopted to facilitate data exchange between programs. The records in a HEC-DSS file are defined by a pathname which contains six parts. These parts allow easy recognition of the data from the pathname. By fixing the pathname form, programs can define pathname parts from model data to provide easy access HEC-DSS data. The data are placed into "manageable" blocks. These blocks are handled automatically and provide efficient reference to time for uniform time-series data.

The HEC-DSS data types are:

- Regular Interval Time-Series Data
- Irregular Interval (No Interval) Time-Series Data
- Paired (or Curve) Data
- Text Data

HEC-5 make use of the regular interval time-series data to define input time-series data and to write user-defined output data.

B.1.2 Pathnames

The pathname for HEC-DSS records consist of 6 parts. The parts are separated by a slash (/). The parts are referenced by the letters: A, B, C, D, E, and F. For example: /A/B/C/D/E/F/ Each part may contain from zero to 32 characters. The total pathname may contain up to a total of 80 characters.

B.1.3 Regular Interval Time-Series Conventions

The parts of the pathname should follow the naming convention:

A - Group or Basin Name (e.g., SCIOTO)

B - Location Name (e.g., CIRCLEVILLE)

C - Parameter (e.g., FLOW)

D - Block Start Date (e.g., 01MAR1959)

E - Time Interval (e.g., 3HOUR)

F - Additional Qualifiers (e.g., OBS)

An example Pathname is:

/SCIOTO/CIRCLEVILLE/FLOW/01MAR1959/3HOUR/OBS/

Time-Series data are stored in blocks with a fixed length for each time interval. For example, daily data is stored in blocks comprising one year of data. Each block will contain 365 or 366 data values, regardless of how many actual values were stored. A place holder (or missing data flag) of -901.0 is used where there are no actual values. If we have recorded only 5 daily values, there would be 360 missing data place holders (-901.0).

An example listing from a block of data for six-hour time interval would take the form:

```

/KANAWHA/BLNO7/FLOW/01MAR1977/6HOUR/OBS/
START = 01MAR1977, 0600 HRS; END = 31MAR1977, 2400 HRS; # DATA = 124
UNITS = CFS          TYPE = PER-AVER
01MAR77, 0600;      -901.  -901.  -901.  -901.  -901.  -901.
02MAR77, 1800;      -901.  -901.  -901.  -901.  -901.  -901.
04MAR77, 0600;      -901.  -901.  -901.  -901.  -901.  -901.
05MAR77, 1800;      -901.  -901.  -901.  -901.  -901.  -901.
07MAR77, 0600;      -901.  -901.  -901.  -901.  -901.  -901.
08MAR77, 1800;      -901.  -901.  -901.  -901.  -901.  -901.
10MAR77, 0600;      -901.  -901.  -901.  -901.  -901.  -901.
11MAR77, 1800;      -901.  -901.  12104.  9987.  9729.  9541.
13MAR77, 0600;      9209.  8197.  7964.  8514.  8405.  7489.
14MAR77, 1800;      7284.  8520.  8389.  7444.  7309.  8854.
16MAR77, 0600;      8328.  7706.  7628.  7300.  6066.  5526.
17MAR77, 1800;      6229.  8477.  8786.  9076.  9052.  9008.
19MAR77, 0600;      7610.  7593.  7771.  9176.  8668.  8107.
20MAR77, 1800;      8212.  8884.  7883.  6803.  6397.  6653.
22MAR77, 0600;      -901.  -901.  -901.  -901.  -901.  -901.
23MAR77, 1800;      -901.  -901.  -901.  -901.  -901.  -901.
25MAR77, 0600;      -901.  -901.  -901.  -901.  -901.  -901.
26MAR77, 1800;      -901.  -901.  -901.  -901.  -901.  -901.
28MAR77, 0600;      -901.  -901.  -901.  -901.  -901.  -901.
29MAR77, 1800;      -901.  -901.  -901.  -901.  -901.  -901.
31MAR77, 0600;      -901.  -901.  -901.  -901.

```

The valid time intervals are even subdivisions of an hour or day, plus the usual calendar increments. The valid intervals and their standard block length are:

Valid Data Intervals	Block Length
1MIN, 2MIN, 3MIN, 4MIN, 5MIN, 10MIN	One Day
15MIN, 20MIN, 30MIN, 1HOUR, 2HOUR, 3HOUR, 4HOUR, 6HOUR, 8HOUR, 12HOUR	One Month
1 DAY	One Year
1 WEEK, 1 MON	One Decade
1 YEAR	One Century

The "D" part of the pathname is the starting date of the block (not necessarily the starting date of the data). It must be a nine character military style date.

01MAY1986	O.K.
01May1986	Invalid - Lower case
01MAY86	Invalid - Must be 1986
MAY1986	Invalid - Must contain the day

01MAY1986 is a valid block start date for intervals of 5MIN through 12HOUR. It is not valid for 1DAY or above. For an interval of 1DAY, the block start date will always be 01JAN19--.

The "header" contains the units of the data (e.g. CFS, FEET), and the data type. There are 4 data types:

- Period Average
- Instantaneous
- Period Cumulative
- Instantaneous Cumulative

Period average data is stored as end-of-period data. Thus, daily period average data is typically stored at a time of 2400 hours. Instantaneous data is stored at the time it is measured.

How about daily flows measured at 8:00 a.m.? That's ok - a time offset is kept in the header. However the data must be measured at 24 hour intervals. Daily data that is measured at 7:00 a.m. one day, and 9:00 a.m. the next probably should be stored as "irregular interval time series data".

B.2 HEC-DSS Utility Programs

There are several programs written as utilities to the HEC-DSS. They include:

DSPLAY - Graphical plotting package. Plots (and tabulates) data stored in the standard conventions on a wide variety of graphical devices, the most common being Tektronix terminals.

DSSUTL - Basic data management utility program. Provides a means for tabulating, editing, copying, deleting, renaming, etc. data.

DSSMATH - Provides a wide variety of mathematical operations for HEC-DSS data.

REPGEN - Produces "publication quality" reports of HEC-DSS data.

Data Entry Programs - Many data entry programs are available for entering data into HEC-DSS from a wide variety of formats.

B.3 HEC-DSS Catalog Function

Many utility program access a HEC-DSS file's "catalog". A catalog is a list of pathnames in a separate file (at a given point in time). It is numbered and is usually ordered alphabetically by pathname parts. The catalog also provides information about the records, such as when they were last written to, by what program, and how much data the record contains.

Most utility program can use the catalog number or "reference number" to identify pathnames. For example, a DSPLAY plot may be generated by the command "PLOT 1,3,4", instead of having to specify each of three pathnames. The catalog can also be used to identify pathnames by matching pathname parts, called "selective catalog". For example, to copy all observed flow data to another HEC-DSS file in DSSUTL, the command "CO C=FLOW, F=OBS" might be given.

Example Catalog for a HEC-DSS File

HECDSS Complete Catalog of Record Pathnames in File 0000DATA*MASTDB

Catalog Created on Mar 6, 1990 at 15:24 File Created on Jan 8, 1990
 Number of Records: 30 DSS Version 6-DA
 Sort Order: ABCFED

Ref. Number	Tag	Program	Last Written Date	Last Written Time	Type	Vers	Data	Record Pathname
1	T3	DSSPD	06MAR90	15:22	RTS	1	366	/AMERICAN/AT FAIR OAKS/FLOW/01JAN1988/1DAY/OBS/
2	T4	DSSTS	06MAR90	15:22	RTS	2	365	/AMERICAN/AT FAIR OAKS/FLOW/01JAN1989/1DAY/OBS/
3	T11	DSSTS	06MAR90	15:22	RTS	3	365	/AMERICAN/BLUE CANYON/PRECIP-INC/01JAN1987/1DAY/OBS/
4	T9	DSSTS	06MAR90	15:22	RTS	4	366	/AMERICAN/BLUE CANYON/PRECIP-INC/01JAN1988/1DAY/OBS/
5	T12	DSSTS	06MAR90	15:22	RTS	1	365	/AMERICAN/BLUE CANYON/PRECIP-INC/01JAN1989/1DAY/OBS/
6	T26	DSSTS	20FEB90	09:30	RTS	9	365	/AMERICAN/FOLSOM/ELEV/01JAN1987/1DAY/OBS/
7	T25	DSSTS	20FEB90	09:30	RTS	4	366	/AMERICAN/FOLSOM/ELEV/01JAN1988/1DAY/OBS/
8	T27	DSSTS	20FEB90	09:30	RTS	1	365	/AMERICAN/FOLSOM/ELEV/01JAN1989/1DAY/OBS/
9	T21	DSSTS	20FEB90	09:30	RTS	4	365	/AMERICAN/FOLSOM/EVAP-PAN/01JAN1986/1DAY/OBS/
10	T18	DSSTS	20FEB90	09:30	RTS	1	365	/AMERICAN/FOLSOM/EVAP-PAN/01JAN1987/1DAY/OBS/
11	T16	DSSTS	20FEB90	09:30	RTS	1	366	/AMERICAN/FOLSOM/EVAP-PAN/01JAN1988/1DAY/OBS/
12	T23	DSSTS	20FEB90	09:30	RTS	1	365	/AMERICAN/FOLSOM/FLOW-OUTLET/01JAN1987/1DAY/OBS/
13	T22	DSSTS	20FEB90	09:30	RTS	6	366	/AMERICAN/FOLSOM/FLOW-OUTLET/01JAN1988/1DAY/OBS/
14	T24	DSSTS	20FEB90	09:30	RTS	2	365	/AMERICAN/FOLSOM/FLOW-OUTLET/01JAN1989/1DAY/OBS/
15	T19	DSSTS	20FEB90	09:30	RTS	1	365	/AMERICAN/FOLSOM/FLOW-POWER/01JAN1987/1DAY/OBS/
16	T17	DSSTS	20FEB90	09:30	RTS	2	366	/AMERICAN/FOLSOM/FLOW-POWER/01JAN1988/1DAY/OBS/
17	T20	DSSTS	20FEB90	09:30	RTS	1	365	/AMERICAN/FOLSOM/FLOW-POWER/01JAN1989/1DAY/OBS/
18	T1	DSSPD	06MAR90	15:22	PD	1	52	/CALAVERAS/NEW HOGAN/STAGE-FLOW//USGS/
19	T2	DSSPD	06MAR90	15:22	PD	1	52	/CALAVERAS/NEW HOGAN/STAGE-FLOW/RT #13/30JUN1980/USGS/
20	T6	DSSPD	06MAR90	15:22	PD	1	46	/DRY CR/NR GEYSERVILLE/STAGE-FLOW/RT #34/07MAR1986/USGS/
21	T5	DSSPD	06MAR90	15:22	PD	1	66	/DRY CR/NR GEYSERVILLE/STAGE-FLOW/RT #38/30SEP1987/USGS/
22	T8	DSSPD	06MAR90	15:22	PD	1	60	/DRY CR/NR LEMONCOVE/STAGE-FLOW//USGS/
23	T15	DSSPD	06MAR90	15:22	PD	1	14	/DRY CR/WARM SPRINGS/ELEV-AREA//01OCT1983/POLY/
24	T7	DSSPD	06MAR90	15:22	PD	1	62	/DRY CR/WARM SPRINGS/STAGE-FLOW//USGS/
25	T29	DSSTS	06MAR90	15:22	RTS	3	365	/FEATHER/QUINCY/PRECIP-INC/01JAN1982/1DAY/OBS/
26	T28	DSSTS	06MAR90	15:22	RTS	2	365	/FEATHER/QUINCY/PRECIP-INC/01JAN1983/1DAY/OBS/
27	T30	DSSTS	06MAR90	15:22	RTS	2	366	/FEATHER/QUINCY/PRECIP-INC/01JAN1984/1DAY/OBS/
28	T14	DSSTS	06MAR90	15:22	RTS	1	365	/FEATHER/SIERRAVILLE/PRECIP-INC/01JAN1986/1DAY/OBS/
29	T13	DSSTS	06MAR90	15:22	RTS	1	365	/FEATHER/SIERRAVILLE/PRECIP-INC/01JAN1987/1DAY/OBS/
30	T10	DSSTS	06MAR90	15:22	RTS	1	366	/FEATHER/SIERRAVILLE/PRECIP-INC/01JAN1988/1DAY/OBS/

B.4 Entering Data into a HEC-DSS file

B.4.1 DSSTS

This program provides general data entry for regular-interval time-series data. The program can be run interactively as a DOS program. The required information is prompted for, with the user entering the data in response. The program can also be run with an input file created with a text editor.

When data values are input, several values can be input on one line. Missing data can be entered as M, or -901. As data are entered, the date and time for each value is given as a prompt (see example below).

DSSTS logs a copy of your input. If you "blow it" (press the break key instead of the return key). You can use the log file (workfile W2) as input to return to where you left off.

The program documentation is included in: *HEC-DSS User's Guide and Utility Program Manuals*.

 Example Data Entry with DSSTS

```

DSSTS
ENTER DSS FILE NAME
FILE = DATABAS
      ----DSS---ZOPEN; CREATED RANDOM FILE: DATABAS
      ----DSS---ZOPEN   NEW FILE OPENED  71  DATABAS

ENTER PATHNAME, OR PATHNAME PART(S), OR FINISH
I>/SCIOTO/WALDO/FLOW/01JAN1988/1DAY/OBS/
/SCIOTO/WALDO/FLOW/01JAN1988/1DAY/OBS/
ENTER UNITS OF DATA (E.G. CFS, FEET)
I>CFS
ENTER DATA TYPE (E.G. PER-AVER, INST-VAL)
I>INST-VAL
ENTER THE DATE AND TIME FOR THE FIRST DATA VALUE
I>23DEC1987 0700
Enter data values.
Enter END at the beginning of the line when done.
23DEC87, 0700 >933
24DEC87, 0700 >933.5 934 935 938 M 940
30DEC87, 0700 >944.3
31DEC87, 0700 >M
01JAN88, 0700 >942.1 944 946 949
05JAN88, 0700 >END
---DSS---ZWRITE FILE 71, VERS. 1 /SCIOTO/WALDO/FLOW/01JAN1987/1DAY/OBS/
---DSS---ZWRITE FILE 71, VERS. 1 /SCIOTO/WALDO/FLOW/01JAN1988/1DAY/OBS/
ENTER PATHNAME, OR PATHNAME PART(S), OR FINISH
I>B=DUBLIN C=STAGE
/SCIOTO/DUBLIN/STAGE/01JAN1988/1DAY/OBS/
ENTER UNITS OF DATA (E.G. CFS, FEET)
I>FEET
ENTER DATA TYPE (E.G. PER-AVER, INST-VAL)
I>INST-VAL
ENTER THE DATE AND TIME FOR THE FIRST DATA VALUE
I>27DEC87 0800
Enter data values.
Enter END at the beginning of the line when done.
27DEC87, 0800 >10.73
28DEC87, 0800 >10.88
29DEC87, 0800 >11.02 11.21
31DEC87, 0800 >M
01JAN88, 0800 >11.20 11.22 11.22
04JAN88, 0800 >11.24
05JAN88, 0800 >END
---DSS---ZWRITE FILE 71, VERS. 1 /SCIOTO/DUBLIN/STAGE/01JAN1987/1DAY/OBS/
---DSS---ZWRITE FILE 71, VERS. 1 /SCIOTO/DUBLIN/STAGE/01JAN1988/1DAY/OBS/

ENTER PATHNAME, OR PATHNAME PART(S), OR FINISH
I>FINISH
      ----DSS---ZCLOSE FILE  71
              NO. RECORDS=    4
              FILE SIZE=  3686 WORDS,  33 SECTORS
              PERCENT INACTIVE=  0.00

STOP
  
```

B.4.2 WATDSS

This is a specialized program to load daily streamflow data from a WATSTORE file. It is easy to use; no preprocessing of the data is necessary. WATDSS can substitute station names for the B part of the Pathname instead of using a USGS gage number. The program source code is often modified to create a program to read other specialized (local) formats. Program documentation is included in: *HEC-DSS User's Guide and Utility Program Manuals*.

Sample WATSTORE file:

3	1447800192710	1	166.	119.	147.	1406.	1281.	864	684.	558.
3	1447800192710	2	579.	441.	369.	423.	2851.	2263.	1540.	1164.
3	1447800192710	3	1111.	2263.	5131.	4795.	3437.	2343.	1817.	1674.
3	1447800192710	4	1227.	958.	864.	774.	729.	639.	599.	0.
3	1447800192711	1	579.	579.	958.	1674.	1603.	1343.	1057.	904.
3	1447800192711	2	819.	729.	729.	684.	684.	639.	599.	558.
3	1447800192711	3	1003.	4795.	2931.	1746.	1674.	1478.	1227.	1164.
3	1447800192711	4	1164.	958.	1057.	1164.	1111.	1057.	0.	0.
3	1447800192712	1	1003.	1003.	1406.	1227.	1057.	958.	958.	3615.
3	1447800192712	2	2771.	1960.	1674.	1540.	1960.	2263.	1817.	1674.
3	1447800192712	3	1674.	1281.	1164.	1057.	958.	864.	729.	579.
3	1447800192712	4	498.	477.	477.	498.	579.	729.	864.	0.
3	14478001928	1	1111.	864.	639.	579.	558.	518.	498.	477.
3	14478001928	1	518.	558.	477.	477.	459.	477.	459.	459.
3	14478001928	1	441.	423.	405.	423.	353.	290.	290.	274.

B.5 Use of HEC-DSS with HEC-5

B.5.1 HEC-DSS File Specification

Typically the HEC-DSS file (and other files) are specified on the execution line. Data can be “read from” and results “written to” the same HEC-DSS file by specifying `DSSFILE=filename`. For example:

HEC5 INPUT=MYIN.DAT OUTPUT=MYOUT.OUT DSSFILE=MYDSS.DSS

Alternatively, data can be “read from” one HEC-DSS file (`DSSIN=filename`) and results “written to” a different HEC-DSS file (`DSSOUT=filename`). For example:

HEC5 INPUT=MYIN.DAT OUTPUT=MYOUT.OUT DSSIN=MYIN.DSS DSSOUT=MYOUT.DSS

When the HEC-5 menu is used, the HEC-DSS file names are given as menu input items.

B.5.2 HEC-DSS Read and Write

Generally, to have an application program read or write to a HEC-DSS file a **ZR** and/or **ZW** Record is inserted into the input file. The **ZR** Record indicates which data should be read from HEC-DSS, and the **ZW** Record indicates that data are to be written to HEC-DSS. The **JZ** Record is used to specify the HEC-5 data to write to HEC-DSS.

Several of the HEC-DSS Pathname parts are specified on the **ZR** and **ZW** Records. This is done by using the part letter followed by an equal sign then the Pathname part. For example:

ZR=IN A=SCIOTO, C=FLOW, F=OBS

HEC5 obtains inflows to a river or reservoir on **IN** Records. Instead of defining all the flow data on **IN** Records, the flow can be read from HEC-DSS using a **ZR** Record, which follows the date/time data on the **BF** Record. Note, in the above example the data read from HEC-DSS is for the **IN** Records. When reading data from HEC-DSS, the format code (**BF** Record, field 2) must be 2.

Without **HEC-DSS**, the input form is:

```

...
BF  date and time information . . .
IN  period by period flow values. . .
IN  ...
IN  ...
...

```

Example Without HEC-DSS:

ED	.	.	.	.	.	.	.	.	.	.
BF	2	50	50	22010100		24		1900		
IN	31									
IN	72	111	209	111	94	99	106	90	146	282
IN	133	109	112	116	121	170	257	147	136	177
IN	161	180	187	175	162	147	125	107	104	99
IN	95	102	110	115	145	148	123	113	125	150
IN	109	99	102	105	94	175	325	139	102	94
IN	42									
IN	122	193	203	268	315	434	662	652	509	405
IN	290	209	277	349	358	243	360	562	553	560
IN	539	540	581	1823	6480	12896	14766	9182	5425	3648
IN	2662	2117	1816	1803	2074	2553	2174	1686	1391	1243
IN	1153	1084	1239	4325	5961	5104	3761	8096	26933	29171
EJ										
ER										

With HEC-DSS, the input form is:

```

...
BF 2 ... date and time information ...
ZR=IN A=RED RIVER, C=FLOW, F=OBS

```

Data is retrieved for each location specified in the input, using the name on the Identification (**ID**) Records as the B part of the Pathname, unless the B part is specified on the **ZR** Record.

Example of Reading Time Series Data from HEC-DSS:

```

...
ED
BF 2 50 50 22010100 24
ZR=IN A=RED RIVER C=FLOW F=OBS
EJ
ER

```

To write data computed by HEC-5 to HEC-DSS, two changes are made to the input data file:

1. Insert a **JZ** Record (after the **J1 - J8** Records). The **JZ** Record specifies what variables and locations data is to be stored. The **JZ** Record specifications are generally the same as the **J8** Record for user defined output.
2. Insert a **ZW** Record following the **BF** Record.

Example of Writing to HEC-DSS:

```

...
BF ...
ZR=IN A=RED RIVER C=FLOW F=OBS
ZW A=RED RIVER, F=COMPUTED
EJ
ER

```

The remaining parts of the Pathname (other than the **A** and **F** Parts specified on **ZW**) come from the model data, or from HEC-5. The **B** Part comes from the location name on the **ID** Record. The parameter (**C** Part) is determined by HEC-5 (the labels used are shown with the **JZ** input description). The date (**D** Part) and the time interval (**E** Part) come from the **BF** Record.