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| | Engineering and Design<br><br>HYDROMETEOROLOGICAL DATA MANAGEMENT AND ARCHIVING | |
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DEPARTMENT OF THE ARMY
U.S. Army Corps of Engineers
Washington, DC 20314-1000

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Regulation
No. 1110-2-8155

31 July 1996

# Engineering and Design
# HYDROMETEOROLOGICAL DATA MANAGEMENT AND ARCHIVING

## 1. Purpose

This regulation establishes policy and provides guidance and procedures applicable to the management and archiving of hydrometeorological data used for planning/project studies and project operations. It provides a recommended format for archiving data.

## 2. Applicability

This regulation is applicable to all HQUSACE elements and USACE commands involved in civil works projects and activities. This guidance applies to contractors or others performing work for the Corps of Engineers. It applies to hydrologic studies and the hydrometeorologic data of multidiscipline studies and water control management functions. The regulation applies to all data acquired, collected, used, or generated beginning 1 January 1996. Alternatives to the recommended archive format must be approved by CECW-EH.

## 3. References

*a.* ER 1110-2-240, Water Control Management.

*b.* ER 1110-2-249, Management of Water Control Data Systems.

*c.* ER 1110-2-1460, Hydrologic Engineering Management.

*d.* Standard Hydrometeorological Exchange Format (SHEF), NOAA Technical Memorandum NWS WR-180, August 1983.

## 4. Definitions

Appendix A contains definitions of terms used in this regulation.

## 5. General

*a. Data Management Overview.* The Corps of Engineers obtains hydrometeorological data from a variety of sources. It is the using element's responsibility that all data, regardless of its origin, be reasonable and accurate before use in studies or for operational purposes. After use, all appropriate data must be archived as described herein. Archiving is required to provide data for project or study accountability, to enable Corps offices to disseminate and/or exchange data, and to provide a consistent data file system suitable as legal documentation.

*b. Data Categories.* For the purposes of this regulation, data is divided into three categories: time series data, XY data, and supplementary data. The processing, management, and archiving of spatial data, imagery, geographic information systems (GIS), and other data are not addressed in this regulation.

(1) Time series data. A single data variable that changes with time. Examples of time series data are: hourly precipitation, maximum daily air temperature, instantaneous river stage, or daily visitor-day attendance.

(2) XY data. A series of pairs of two data variables that define a single valued functional relationship. Examples of XY data are: stage-discharge curve, elevation-damage curve, depth-temperature profile, water

surface profile, or flood frequency curve. An XY data set may have an associated reference date/time.

(3) Supplementary data. Other data associated with model input, model output, parameters, status, or control sequences. Examples of supplementary data are: rainfall-runoff model input files, water surface profile output files, tabular reports of damages for alternative plans, peak discharges, weather bulletins, or news reports.

## 6. Data Processing

Processing of study and operational data includes data conversion, validation, and derivation of secondary data.

(1) Data conversion. The conversion process for data includes the unpacking and/or transformation of raw data from its original acquired form to a functional form consisting of engineering units such as feet, meters, or degrees Fahrenheit. The raw values must not be corrected, edited, or changed in any way from those received from a data acquisition source or cooperating agency.

(2) Data validation. Any data used in studies or in making an operational decision must be validated. In operational use, data that has been validated must not be returned to the raw database. Validated data should be written to a processed database as part of the screening process. Validation may be accomplished by automated or manual means. This process may include estimating values for missing or erroneous data.

(3) Derivation of secondary data. The derivation of secondary data items from primary data includes the application of one or more mathematical functions. Examples of deriving secondary data are: obtaining river flow from river stage readings using a rating curve, computation of mean daily flow from hourly values, and computation of incremental precipitation from cumulative precipitation data.

## 7. Archiving

*a. Organization of archive file.* The archive file is organized to provide a logical grouping of related data. Corps operational data shall be organized into **raw** archive files and **processed** archive files. Raw and processed data will each be partitioned into separate archive files by geographic region, calendar year, and data category (i.e., time series, XY, and supplementary). Corps study data shall be organized into **study** archive files. Study data will be partitioned into separate archive files by data category (i.e., time series, XY, and supplementary). Appendix B shows the structure of an archive file.

*b. Archive content and ordering.*

(1) Time series data. The recommended format of time series archive records is defined in Appendix C. Within each time series archive file, the data will be organized alphabetically by station ID. Within the station ID, the data will be organized alphabetically by parameter. Within the parameter, the data will be organized by increasing date/time.

(a) Operational data. This must include times series data that are required to define the manner in which a Corps project was operated. For a reservoir project, a minimum of inflow, outflow, and pool elevation data would normally be required. The archive file may also include gate settings, storage, evaporation, or other time series data that define the operation of the project.

(b) Study data. This must include times series data used in the study, including precipitation, flow, and other data used to develop unit hydrograph, routing, or other hydrologic parameters. It includes data used to test model behavior, or as input to produce model results. The computed model results must be included for all conditions relevant to the study. This may include model-computed hydrographs, stages, reservoir storage, and pool elevation.

(2) XY data. The recommended format of archive XY records is defined in Appendix D. Within each XY archive file, the data will be organized alphabetically by station ID. Within the station ID, the data will be organized alphabetically by X parameter, and then alphabetically by Y parameter.

(a) Operational data. The archive must include XY records that are required to define the operation of the project. This may include stage-discharge, elevation-area-storage, storage-outflow, or other relationships. XY data used in project operations in a given

year should be archived each year regardless of whether or not the data changed from the previous year.

(b) Study data. The archive must include XY records that are required to define the study. This may include stage-discharge rating curves, stage-damage relationships, or similar functions. Analysis results such as flow-frequency curves and flow-duration curves should be included.

(3) Supplementary data. The recommended format of supplementary archive records is defined in Appendix E. The order of records in the supplementary archive file is determined by the local Corps office.

(a) Operational data. Any supplementary information that contributes to the determination of a critical model step, flow forecast, release determination, or related step should be archived. This would include simulation model input files, model output files, macro files, decision memos, or other related information.

(b) Study data. Model input and the corresponding output files that evaluate all alternative plans investigated should be stored as part of the archive records.

*c. Media and distribution of archived data.*

(1) Media.

(a) Care must be exercised when selecting the media on which to store archive files. The media selected should have a relatively long life span, both in its physical characteristics and the availability of devices to read the media. The media selected should be vendor-independent and commonly available in other Corps offices. Archive files should be structured to fit on a single media item.

(b) As new storage devices improve with advancements in technology, all previous archive files should be copied to new media.

(2) Storage of archive files.

(a) Multiple copies of each archive file must be made. One write-protected copy of the archive must be stored at the responsible office. A duplicate copy of the archive file must be stored at the next higher headquarters office, or at another offsite location approved by the next higher headquarters.

(6) Archive files containing raw data will be retained a minimum of 5 years. Archive files containing study or processed data must be kept indefinitely.

FOR THE COMMANDER:

ROBERT H. GRIFFIN
Colonel, Corps of Engineers
Chief of Staff

5 Appendices
APP A - Definitions
APP B - Archive File Structure
APP C - Time Series Record Definition
APP D - XY Data Record Definition
APP E - Supplementary Data Record Definition

# Appendix A
# Definitions

**Archive** Data stored for permanent or long-term purposes.

**Archive File** A collection of archive data stored in a single computer file.

**ASCII** American Standard Code for Information Interchange. This is the standard computer representation of characters. In this document, ASCII is implied to be the subset of the 95 printable characters.

**ASCIINAME** The subset of ASCII characters that may be used to form names of data sets, files, or other entities. The valid subset includes lowercase alphabetic (a-z), uppercase alphabetic (A-Z), numeric (0-9), minus sign (-), pound sign (#), and underscore (_) characters. The name must begin with an alphabetic or numeric character.

**Data** Information that is pertinent to hydrologic engineering and can be reasonably stored on a computer. This not only includes measured and computed values, such as stage and flow, but may include program input and output files, weather bulletins, and memos. Items such as paper maps and reports are not considered in this regulation.

**Format** Organization of data in fields, records, and files.

**Geographic Unit** A geographic area which is typically a major watershed or a collection of small watersheds.

**Media** The physical substance that holds computer data files. Examples are cassette tapes, floppy diskettes, and CD-ROM disks.

**Model** A computer program that, when combined with the appropriate data, will represent the behavior of a physical process.

**Operational Data** Hydrometeorological data that has been gathered or generated primarily for use in the daily operation of Corps of Engineers projects or projects for which the Corps has operational control.

**Primary Data** Data directly measured. This generally includes river stages, but not river flow values. (See Secondary Data.)

**Processed Data** Data that has been screened, validated, or computed. (See Raw Data.)

**Project** A project owned by the Corps or for which the Corps has operational responsibility.

**Raw Data** Data as received by sensors, or some other means, and loaded into a data file, but not yet screened or validated. (See Processed Data.)

**Record** A set of associated information within a computer file. A record may consist of one or more lines in the file.

**Secondary Data** Data calculated from primary or other secondary data. Such data includes river flow values that are generally derived from river stages by application of a rating curve. (See Primary Data.)

**SHEF** Standard Hydrometeorological Exchange Format. A computer format used for the exchange of operational hydrometeorological data between Federal agencies and other cooperating agencies.

**Study Data** Hydrometeorological data that has been assembled or generated for use in a Corps study.

# Appendix B
# Archive File Structure

## 1. Naming Archive Files

*a. Components.* The components of the name must be made up of the characters defined under ASCIINAME in Appendix A. The name of each archive file will be of the form:

/ Office / ArchiveType / Ident / Date / DataType

where

| | |
|---|---|
| Office | is the five-character Corps office symbol, |
| ArchiveType | is [RAW\|PROCESSED\|STUDY], |
| Ident | is study name or geographic unit name, |
| Date | is study date, or archive calendar year, |
| DataType | is [TS\|XY\|SUP]. |

Example #1: Part A of a study by Rock Island District at Harpers Ferry, Iowa.

/CENCR/STUDY/Harpers_Ferry_Part_A/10MAY1994/TS

/CENCR/STUDY/Harpers_Ferry_Part_A/10MAY1994/XY

/CENCR/STUDY/Harpers_Ferry_Part_A/10MAY1994/SUP

Example #2: Real-time data for Allegheny Basin, Pittsburgh District, for calendar year 1994.

/CEORP/RAW/Allegheny/1994/TS

/CEORP/RAW/Allegheny/1994/XY

/CEORP/RAW/Allegheny/1994/SUP

/CEORP/PROCESSED/Allegheny/1994/TS

/CEORP/PROCESSED/Allegheny/1994/XY

/CEORP/PROCESSED/Allegheny/1994/SUP

*b. Geographic unit.* Real-time data archives will be divided into one or more archive data files based on a geographic unit. The geographic unit should remain fixed from one archival file to another. All data stations will be assigned to one and only one geographic unit.

*c. Year.* Each calendar year of data will be kept in a separate archive file.

## 2. General Structure

The archive file is composed of specific text records, each made up of ASCII characters only. The general structure of the file is:

a) Header Record
b) Index Records

c) Data Records (as required)
. . . .
. . . .

*a. Header record.* At the beginning of each archive file there will be a header record that contains information about the file. The header may also contain text comments providing a brief description of the data. Header records shall adhere to the following style:

::H: OFFICE= office symbol

::H: ARCHIVE= [STUDY|RAW|PROCESSED]

::H: NAME= study, or geographical unit

::H: DATE= date, or calendar year

::H: TYPE= [TS|XY|SUP]

::H:

::COM: Comment 1

::COM: Comment 2

::H:

*b. Index records.* The index records must immediately follow the header record. They contain one line for each data record in the file. The index entry is unique for each data type.

(1) Time series (TS) records

::I-TS: ID=stationID,PARM=parameter,NAME=name,ST=state

where

stationID - taken from SHEF id,
parameter - taken from SHEF parameter code
name - defined by Corps office
state - two character state FIPS code

(2) XY records

::I-XY: ID=stationID,X=xParameter,Y=yParameter,NAME=name,ST=state

where

stationID - defined by Corps office
xParameter - defined by Corps office
yParameter - defined by Corps office
name - defined by Corps office
state - two character state FIPS code

(3) Supplementary (SUP) records

::I-SUP: Comment describing supplementary record information

# APPENDIX C
# TIME SERIES RECORD DEFINITION

## 1. SHEF Format

For time series data the archive data record will be written in the SHEF format. It will be ASCII characters with a maximum column width of 80 characters. Optional formats available in SHEF are restricted as defined below. Each new archive data record will be surrounded by a starting and ending string to ensure its uniqueness. An example of time series archive records is provided below.

*a. Start line*. The initial line will consist of the time series index line defined above with the begin key of "::B-TS:". The actual archive data will follow on a new line one or more lines below the starting string.

*b. Body*.

(1) Format specifier. Data with evenly spaced time intervals will be output using the SHEF ".E" format with the ".En" continuation specifier. Data with unevenly spaced time intervals will be output using the SHEF .A format with the .An continuation specifier.

(2) The station ID will be locally defined. To avoid ambiguity with other Corps office and agency stations, it is recommended the ID contain five to eight characters formed as xxxiiiii where xxx is the three-character Corps office symbol and iiiii is a three- to five-character station mnemonic.

(3) The full date code (yymmdd) is required.

(4) The time zone code is mandatory. It must be either Z for Coordinated Universal Time (UTC) or standard time for a designated time zone. Local time or Daylight Savings Time are not permitted.

(5) Relative time codes are not permitted.

(6) Each ".A" format will contain data for only one parameter. Continuation lines should be used to avoid repeating the station information.

*c. End line*. The data record will be terminated by the end string "::E-TS:" followed by the same information on the start line.

Example #1: River stages below Black Butte Reservoir, Sacramento District, with unevenly spaced time intervals.

::B-TS: ID=SPKBLB,PARM=HG,NAME=Black Butte Reservoir,ST=CA

.A SPKBLB 930301 PS

.A1 DY9303010805/HGI 5.75

.A2 DY9303031230/HGI 6.02

.A3 DY9303031800/HGI 6.06

.A4 DY9303040820/HGI 6.22

.A5 DY9303081215/HGI 5.04

. . . .

. . . .

::E-TS: ID=SPKBLB,PARM=HG,NAME=Black Butte Reservoir,ST=CA

Example #2: Daily precipitation at Huntington, WV, in Huntington District with evenly spaced time intervals.

::B-TS: ID=ORHHNTW,PARM=PP,NAME=Huntington,ST=WV

.E ORHHNTW 940101 Z DY9401012400/PPD/DID01

.E1 0.02/0.27/1.03/0.00/0.00/0.00/0.22/0.59/0.00/0.00

.E2 0.00/0.00/0.00/2.21/1.04/0.00/4.88/1.37/0.40/0.05

. . . .

. . . .

::E-TS: ID=ORHHNTW,PARM=PP,NAME=Huntington,ST=WV

# APPENDIX D
# XY DATA RECORD DEFINITION

## 1. Start Line

The initial line will consist of the XY index line defined above with the begin key of "::B-XY:".

## 2. Body

The body of an XY record will contain:

(a) A date/time title line. An effective date and time should be provided for XY records. Title information should normally be provided for all XY data records.

(b) An X-parameter definition line. The record must contain one X-parameter definition line containing the X-parameter and its units.

(c) One or more Y-parameter definition lines. The record must contain at least one Y-parameter definition line containing the Y-parameter, its units, and optionally a numeric value and its units. More than one Y-parameter may be used for a family of curves or for a multiple parameter relationship. Each curve may be identified by a label.

(d) Comment lines. Any number of comment lines may be used.

(e) Data values. The values are to be written in a column format. Each data line contains one X-value and one each of the Y-values. Each data value is separated from another by a comma and/or any number of optional spaces.

## 3. End Line

The data record will be terminated by the end string "::E-XY:" followed by the same information on the start line.

## 4. Example 1

Elevation, area, storage relationship

::B-XY: ID=BVGA4,X=elevation,Y=area,Y=storage,NAME=Beaver Lake,ST=OH

DATE=01JUN1964, TITLE=Beaver Lake Area-Capacity Relationship

X=ELEVATION, UNITS=feet

Y=AREA, UNITS=acres, LABEL=Area

Y=STORAGE, UNITS=acre-feet,LABEL=Storage

::COM: Relationship determined before filling of lake.

::COM: Sediment may have since altered the relationship.

1115.0, 2500, 200000

1117.0, 7500, 300000

1119.0, 10000, 500000

1125.0, 30000, 650000

1130.0, 50000, 900000

::E-XY: ID=BVGA4,X=elevation,Y=area,Y=storage,NAME=Beaver Lake,ST=OH

### 5. Example 2

Family of gate discharge curves

::B-XY: ID=SVDW,X=elevation,Y=outflow,NAME=Big Bend Dam,ST=CO

DATE=21Jun1984, TITLE=BIG BEND DAM

X=ELEVATION, UNITS=feet

Y=OUTFLOW, UNITS=cfs, VALUE=2.0 feet

Y=OUTFLOW, UNITS=cfs, VALUE=6.0 feet

Y=OUTFLOW, UNITS=cfs, VALUE=12.0 feet

Y=OUTFLOW, UNITS=cfs, VALUE=24.0 feet

672.0, 0, 0, 0, 0

684.0, 8000, 25000, 35000, 35000

696.0, 10000, 32000, 50000, 112000

708.0, 15000, 43000, 86000, 180000

716.0, 18000, 49000, 95000, 192000

::E-XY: ID=SVDW,X=elevation,Y=outflow,NAME=Big Bend Dam,ST=CO

# APPENDIX E
# SUPPLEMENTARY DATA RECORD DEFINITION

## 1. Start Line

The first line in a data record of a supplementary archive record should consist of a unique character string as follows: ::B-SUP: ID=aaa, where aaa is an identifier defined by the local office.

## 2. Body

The complete supplemental data for the record is inserted in the file after the initial line described above. The lines can be of the necessary length for input, output, tables, or other information.

## 3. End Line

The last line of the data record will contain a unique character string ::E-SUP: ID=aaa, where aaa is the same identifier as the start line of the record.

## 4. Example

The following example shows a supplementary data record for an HEC1 input file.

```
::B-SUP: ID=RED_PLAN_B
ID        RED RIVER STUDY
ID        STREAMFLOW ROUTING OPTIMIZATION
ID        MUSKINGUM METHOD - Plan B
IT        720     600000          0          16
IO          1          2
OR          2
KK          1
QP       2000       2000       7000       11700      16500      24000      29100      28400
QP      15300      11200       8200        6400       5200       4600          0          0
QI       2200       2200      14500       28400      31800      29700      25300      20400
QI       9300       6700       5000        4100       3600       2400          0          0
QO       2000       2000       2000        7000      11700      16500      24000      29100
QO      15300      11200       8200        6400       5200       4600          0          0
RL          0.         0.
RM         -1         -1.00      -1.00
ZZ
::E-SUP: ID=RED_PLAN_B
```