V.4 INPUT SUMMARY FOR DEFINING FORECAST COMPONENT RATING CURVES

Introduction

This Section describes the input needed to define Rating Curves used by the Operational Forecast System (OFS) Forecast Component.

The information stored in the OFS Rating Curve file contains general information (such as name, location, comments, etc.) and information for stage-discharge conversions.

A deficiency exists in the hydraulic extension option in dealing with the presence of a very wide, flat flood plain on a very small channel. Discharges in the hydraulic extension option are computed from the hydraulic radius and area of an equivalent channel. Near and above the top of the channel, the computed elevation-discharge relation could be erratic. Discharges for the higher stages could be less than those for the lower stages, a result only possible in the loop rating option. A conveyance approach, which accounts for the channel flow and the flood plain flow separately, can be used to overcome these problems but is not currently available.

The methods used to perform stage-discharge conversions are described in Chapter II.4-STGQ.

Syntax Rules

The Rating Curve input use free format input.

The following rules must be followed for proper character string interpretation:

Field location	The first field can start in any column on the input record. Only columns 1 through 72 of the input record are interpreted.
Delimiters	Two successive fields on a record must be separated by at least one blank or one comma. ID RCURVA,ADD
Null fields	A null field is defined as one or more blanks delimited by non-blank delimiters or as two contiguous non-blank delimiters. ENGL 7 0 175 125 ,, OFF=1
Continuations	Certain fields can have continuations. If a continuation record is needed, an ampersand (in any column) must be the last field on the record. COMMENT 'THE FLOOD OF RECORD (CAUSED BY & HURRICANE AGNES) RESULTED IN 6 FEET OF &

WATER FLOWING OVERTOP THE BRIDGE ON ROUTE &
257 AT THE PEAK STAGE (29.05 FEET) OF THE &
FLOOD'

Special characters — Special characters are defined as those symbols used as delimiters. If one of these symbols must be embedded within a field on a record, the entire field must be enclosed in single quotes. Situations where quotes might be used are in descriptions where blanks separate description words or when leading blanks are desired.

'HAZLETON, PA' 'STONEY CREEK' 41.50 76.35

In the following input summary, numbers of each field are used to indicate the expected sequence of the fields on the card. 'TYPE' refers to the type of value expected (A = alphanumeric, R = real, I = integer) and a type of 'A' means that this value may have embedded blanks and if so single quotes must be used to delineate the field. , When certain words must be entered literally, they are shown in the description column in quotes (e.g., 'ADD' or 'ID') but the quotes do not have to be entered on the input.

More than one Rating Curve file may be defined in an input stream. Constraints on the possible values for certain variables are indicated with that variable's description (e.g., River name - 20 character maximum) or in Table 1 (e.g., Discharges - must be positive).

Input Summary

Card	Field	Type	Description
1	1	A	'IDENTIFIER' (or 'ID' or 'I')
	2	A8	Rating Curve identifier; not allowed are: o embedded blanks or all blanks o names starting with @ or '.' o special characters: < > ( ) - o 'ALLRC'
	3	A	Type of input: o Enter 'ADD' if this is the first time a Rating Curve with this ID is defined o Enter 'REPL' if in the operational program a previously identified Rating Curve is to be redefined or for the calibration program if this is a subsequent definition of a Rating Curve that changes within the calibration period; if 'REPL' is specified and the Rating Curve does not exist, it will be added o Enter 'REPLHQ' or 'UPDATE' if only new stage-discharge values will be input

Card	Field	Type	Description
			for the Rating Curve but no other information will be redefined; if either of these options is selected skip cards 2-9 and use the input structure described under 'Input For Updating Stage-Discharge Values'
	4	I	Last date that Rating Curve is applicable (form is mmddyyyy); not used in operational program; for a Calibration System program run in which the Rating Curve does not change or for the latest Rating Curve this field can be left blank
2	1	'A20'	Station name; maximum 20 characters
	2	'A20'	River name; maximum 20 characters
	3	R	Latitude of station (units of degrees decimal, e.g., 37.54)
	4	R	Longitude of station (units of degrees decimal)
3	1	A	Units used in defining Rating Curve: 'ENGL' (or 'E') = data are in English units 'METR' (or 'M') = data are in metric units See Table 2 for units to use for input data.
	2	I	Number of points (stage versus flow pairs) used to define Rating Curve on card 6: 0 = no Rating Curve used
	3	I	Number of channel cross section points (NCROSS) on card 7 used at point where Rating Curve is defined (topwidth versus elevation pairs) 0 = not used (must be zero if number of Rating Curve points is zero) Must be greater than zero if loop rating option is used; if greater than zero it indicates that a hydraulic extension will be used
	4	R	Total upstream drainage area
	5	R	Local drainage area (must be less than or equal to total area)
	6	A2=A4	Indicators for types of forecast product

Card	Field	Type	Description
			generated; optional field; leave blank if none generated; form is Keyword=Code (e.g., 'RR=FLUD') where keyword represents the general types of forecasts: 'RR' = regular river forecast 'RV' = for reservoir 'EX' = for extended 'FF' = for flash flood Codes are: o Regular river forecast: 'DAOP' = optional daily 'DAMA' = mandatory daily 'FLUD' = flood only 'SPRT' = support (Tulsa RFC) o Reservoir forecast: 'RSQ ' = reservoir elevation and inflow 'INF ' = reservoir inflow only o Extended forecast: 'SOOP' = spring outlook - optional 'SOMA' = spring outlook - mandatory 'WSUP' = water supply o Flash flood: 'HWFF' = headwater table and flash flood index 'FFON' = flash flood index only 'HWON' = headwater table only Repeat field 6 for each type of forecast product generated
	7	A	Loop rating indicator: 'LOOP' (or 'L') = loop rating is used (leave blank if loop rating not used)
	8	A3=I	Number of offset factors used to shift the Rating Curve so that it is a straight line on a logarithmic plot; the keyword form is used and is OFF=n, where n is the number of offset or shift factors used on card 6A; blank if linear interpolation/ extrapolation is used (INT=LIN in Field 9)
	9	A3=A3	Indicator for method of interpolation/ extrapolation: INT=LIN = linear interpolation/ extrapolation INT=LOG = logarithmic interpolation/extrapolation Default is logarithmic interpolation/extrapolation.
4	1	R	Primary flood stage (may be followed by 'P'

Card	Field	Type	Description
			if it is provisional, e.g., 15.8P or 'T' for tailwater rating); can enter 'M' for missing The letter 'T' is used to indicate a tailwater rating; the 'T' can follow the flood stage or the flood stage may be omitted by simply including only 'T' as the first field (in which case flood stage defaults to missing)
	2	R	Elevation of gage zero datum (Mean Sea Level); can enter 'M' for missing as long as the number of cross section points equals zero
	3	R	Minimum allowable stage to which Rating Curve may be extended at the lower end; only entered if number of Rating Curve points is non-zero
	4	A2=R	Secondary flood stage; blank if not used; Keyword form is used and is SS=stage value (e.g., SS=10.5)
	5	A2=R	Warning or alert stage; blank if not used; Keyword form is used and is WS=warning stage value (e.g., WS=5.0)

Card 5 is optional and all fields on card 5 pertain to the flood of record.

5	1	A2	'RF' (this is keyword to indicate card is present)
	2	R	Stage
	3	R	Discharge (enter 'M' if not available)
	4	I	Date (form is mmddyyyy or just yyyy); can enter 'M' for missing; zeros can be used for mm or dd
	5	'A20'	Comment (20-character maximum) (optional)

Card 6 only needed if number of Rating Curve points is greater than one on card 3.

6	1,2	R	Stage-discharge pairs to define Rating Curve; must be in ascending order and any number of pairs may be placed on a card except that the first card must contain at least two pairs (e.g., 0.0 0.0 1.0 1000.

Card	Field	Type	Description
			2.0 2000. etc); do not split pairs at the end of a card

Repeat card 6 as needed to provide all stage-discharge pairs. A continuation symbol should not be used.

Card 6A is needed only if the number of offset factors is greater than zero on card 3.

6A	1,2	R	Pairs of stage above which an offset is applied and the corresponding offset value; stage values must be in ascending order and all pairs must go on one card; offset value is defined as the stage difference between the original Rating Curve and the shifted Rating Curve (see Chapter II.4-STGQ - note that a positive shift is a negative offset); rules which apply to these values are: o the offset factor must be less than the corresponding stage value o each stage value must correspond to a defined point on the Rating Curve

Cards 7 and 8 are only needed if NCROSS is greater than zero on Card 3.

7	1,2	R	Elevation-topwidth pairs to define channel cross section; any number of pairs may be placed on a card; elevations are in Mean Sea Level; do not split pairs at the end of a card In the loop rating option the rate of change of topwidth should be less than 150 FT/FT to avoid model instability. Any wider channel should be entered as off-channel storage via card 9. There are no constraints on how large the rate of change of topwidth may be but the presence of a very wide, flat flood plain on a very small channel of 1000 FT/FT could produce erratic stage-discharge relation. Near and above the top of the channel discharges for higher stages could be less than those for lower stages conveyance approach, which accounts for the channel flow and the flood plain flow separately, can be used to overcome these problems but is not currently available.

Repeat card 7 as needed to provide all elevation-topwidth pairs. A

Card	Field	Type	Description

continuation symbol should not be used.

8	1	R	Cross-sectional flow area below first elevation on card 7
	2	R	Bottom slope of channel at point where Rating Curve is defined
	3	R	0.00001 to 0.03 = Manning's roughness coefficient for flood plain above uppermost stage in card 6 - a composite Manning N will be used based on the formula given in Chapter II.4-STGQ-LOOP 0.0 = Manning's value at the uppermost stage in card 6 will be used for all the flood plain >= 1.0 = Variable Manning N must be entered in Card 8A

Cards 8A is needed only if field 3 in card 8 is greater than or equal to 1.0.

8A	1-NCROSS	R	NCROSS Manning N values corresponding to elevations in Card 7; if less than NCROSS values are entered the last Manning N value will be used as default; if this card is entered the computed Rating Curve may not be compatible with the Rating Curve specified in Card 6

Card 9 is needed only if loop option (card 3, field 7) is on.

9	1	R	Time to peak for typical flood in days
	2	R	Discharge at beginning of typical flood (must be less than peak discharge)
	3	R	Peak discharge for typical flood
	4	R	Stage at beginning of typical flood (must be less than peak stage)
	5	R	Peak stage for typical flood
	6	R	Minimum discharge below which loop effects will be ignored; if missing (-999.0) discharge at beginning of typical flood will be used

Card	Field	Type	Description
	7	R	Minimum stage below which loop effects will be ignored; if missing (-999.0) stage at beginning of typical flood will be used
	8	I	Number of cross section points for off-channel storage (NOCS); see Figure 1 for depiction of off-channel storage

Card 10 is need only if NOCS is greater than zero on Card 9.

10	1,2	R	Elevation-topwidth pairs to define off-channel storage cross section; any number of pairs may be placed on a card; elevations are in Mean Sea Level; do not split pairs at end of a card The first channel cross sectional elevation or the minimum stage on Card 9, whichever is larger, will be used as the lower stage limit for loop rating computations. The normal discharge corresponding to the first cross sectional elevation (discharge computed from Manning equation using channel bottom slope) or the minimum discharge on Card 9, whichever is larger, will be used as the lower discharge limit for loop rating computations. Any lower stages or discharges will be interpolated/extrapolated linearly or log-log from the Rating Curve.

Repeat Card 10 as needed to provide all elevation-topwidth pairs. A continuation symbol should not be used.

11	1,2	'A'	Optional information in the form of a keyword field followed by one or more entry fields for each piece of optional information (more than one piece of optional information can be on a card as long as the keyword and entry are on the same card):

Keyword	Entry (type)
'USGS-ID'	USGS identifier (A-8 character maximum)
'NWS-ID'	NWS location identifier (A-5 character maximum)
'BANKFULL-STG'	Bankfull stage (R)
'RIVER-LOC'	River location-distance from mouth (R)
'MOB-STG'	Mobilization stage (R)
'HSA-ID'	Hydrologic Service Area Identifier (A-8

Card	Field	Type	Description
			character maximum)
			'E-19' Date of latest E-19 update - mmyy (I)
			'E-19A' Date of latest E-19A update - mmyy (I)
			'COMMENT' One or more fields ('A'); can be continued onto multiple cards by including a '&' as the last field on each card to be continued; fields after the first cannot be the same as any of the optional information keywords

Repeat cards 1-9 for each Rating Curve to be processed.

Input for Updating Stage-Discharge Values

These options allow the user to update only the Rating Curve portion of the file. Only previously defined Rating Curves may be changed. The REPLHQ option allows all of the points in the Rating Curve to be changed. The UPDATE option is similar except any old stages that are greater than the highest stage input will be retained. The number of points (and the new values) can differ from the old Rating Curve. However, if offset factors are being used, the new Rating Curve must contain all of the stage values associated with offset factors. The cards used for the REPLHQ or UPDATE options are:

2	1	I	Number of input points (stage versus flow pairs) used to define (versus, update) the new Rating Curve.
	2	A	Units used in updating Rating Curve 'blank' = assumes data are in units originally used in defining Rating Curve 'ENGL' (or 'E') = if data are in English units 'METR' (or 'M') = data are in metric units
	3	R	Minimum allowable stage to which Rating Curve may be extended at the lower end.
3	1,2	R	Stage-discharge pairs to define new Rating Curve; must be in ascending order with any number of pairs on a card; do not split pairs at the end of a card; stage values associated with offset factors must be included

Card	Field	Type	Description

Repeat card 3 as needed to provide all stage-discharge pairs for new Rating Curve. Do not use a continuation symbol.

Sample Input

A sample of the input cards used to define Rating Curves is shown in Figure 2.

Error Messages

The error messages encountered in defining Rating Curves are self-explanatory and will not be listed here. Many of the messages follow the general error message taking the form

```
**ERROR** IN FIELD II ON CARD JJ OF INPUT SUMMARY
ACTUAL FIELD AND CARD SEQUENCE NUMBERS=MM NN
```

where II and JJ are the field and card numbers as given in the input summary while MM NN are the actual field and card sequence numbers. The actual numbers may differ from the input summary reference numbers since some of the cards and fields may be repeated.

Table 1. Constraints Placed on Certain Variables

Variables	Constraint or Range Allowed
Primary flood stage, discharges, top widths, areas	Must be greater than or equal to zero
Elevations	Range -220 to 8900 M
Manning's N	Constraint 0.01 to 0.3; recommended range 0.02 to 0.16 for natural stream
Channel bottom slope	Range greater than 0.000002 and less than 0.3

Table 2. Input Data Units for Defining Rating Curves

Parameter	English	Metric
Drainage areas	MI2	KM2
Stages, topwidths, offsets	FT	M
Elevations (Mean Sea Level)	FT	M
Discharge	CFS	CMS
Cross-sectional area	FT2	FT2
Bottom slope	FT/FT	M/M
Manning's roughness coefficient	dimensionless	
River location	MI	KM

See Chapter I.10 for a description of the data units codes.

Figure 1. Typical cross-section active channel and off-channel topwidth representation for use with loop rating option

B = CHANNEL WIDTH FOR HB
BF = FLOOD PLAIN WIDTH
BO = OFF-CHANNEL WIDTH FOR HBO
HB = ELEVATION FOR B
HBO = ELEVATION FOR BO
NCROSS = NUMBER OF CROSS SECTION POINTS FOR CHANNEL
NOCS = NUMBER OF CROSS SECTION POINTS FOR OFF-CHANNEL STORAGE
Y = WATER ELEVATION ABOVE SEA LEVEL

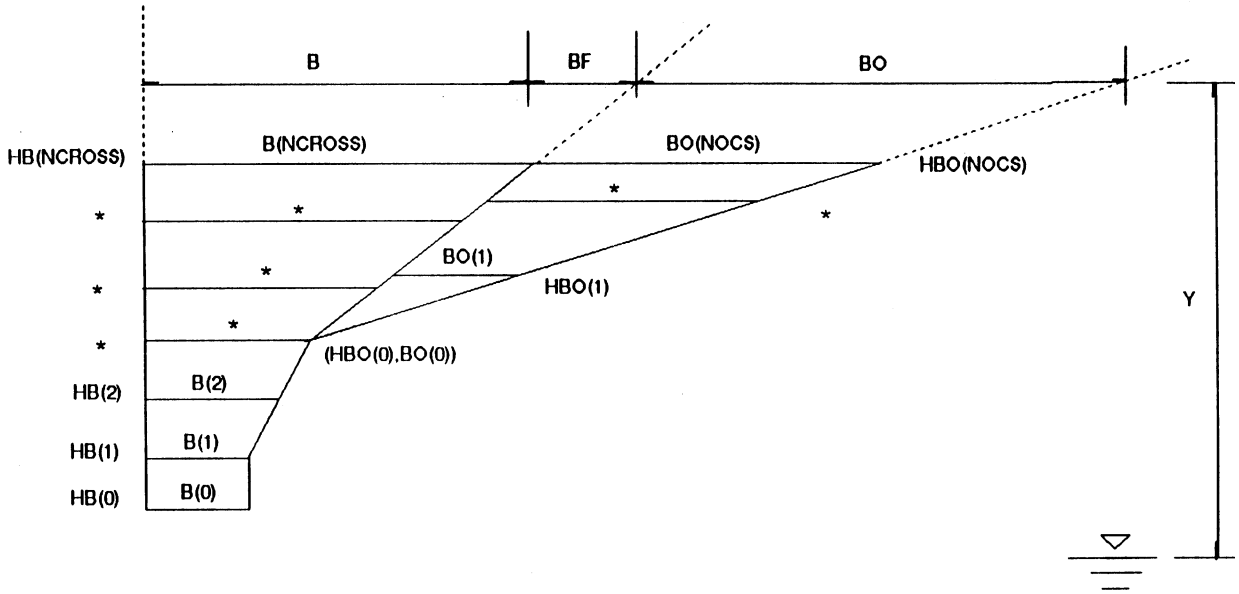

Figure 2. Sample Input for Defining Rating Curves

1a. Add RCURVA: log extrapolation only - no loop rating

```
ID RCURVA ADD
'HAZLETON, PA' 'STONEY CREEK' 41.50 76.35
ENGL 7 0 175 125 RR=FLUD OFF=1
17.33 10.00 0.01 WS=15.0
RF 35.0 69000 06151972 'HURRICANE AGNES'
3.0 180 4.0 280 5.0 420 6.0 600 8.0 1000 13.0 2700 18.0 4400
3.0 -2.0
NWS-ID PAN01
```

1b. Add RCURVB: linear and/or hydraulic extension - no loop rating

```
ID RCURVB ADD
'HAZLETON, PA' 'STONEY CREEK' 41.50 76.35
ENGL 7 7 175 125 RR=FLUD INT=LIN
17.33 10.00 0.01 WS=15.0
RF 35.0 69000 06151972 'HURRICANE AGNES'
5.0 180 6.0 280 7.0 420 8.0 600 10.0 1100 15.0 2700 20.0 4400
13.33 25.0 16.67 50.0 20.00 67.5 26.33 75.0 26.67 112.5
30.0 150.0 40.00 200.0
41.62 0.0005 0.095
NWS-ID PAN01
```

1c. Replace RCURVB: loop Rating Curve option on

```
ID RCURVB REPL
'HAZLETON, PA' 'STONEY CREEK' 41.50 76.35
ENGL 7 7 175 125 RR=FLUD LOOP
17.33 10.00 0.01 WS=15.0
RF 35.0 69000 06151972 'HURRICANE AGNES'
5.0 180 6.0 280 7.0 420 8.0 600 10.0 1100 15.0 2700 20.0 4400
13.33 25.0 16.67 50.0 20.00 67.5 26.33 75.0 26.67 112.5
30.00 150.0 40.00 200.0
41.62 0.0005 0.095 3.0 50 10000 3.3 31.0
NWS-ID PAN01
```

1d. Update RCURVB: will keep any old stages higher than 10.5

```
ID RCURVB UPDATE
5 0.0
0.0 0 2.0 90 5.0 200 9.0 1000 10.5 1300
```

1e. Update RCURVA: all stage-discharge pairs are changed

```
ID RCURVA REPLHQ
8 3.0
5.0 180 6.2 300 7.0 450 8.5 800 9.5 1100 14. 2500 18. 4200
23 7100
```