

V.3.3-FFG FLASH FLOOD GUIDANCE OPERATION

Identifier: FFG

Application: Operational Forecast System programs only

Description: This Operation calculates and stores rainfall-runoff curves based on current soil moisture conditions and stores the latest snow and rainfall-runoff state variables for each area for which runoff is being computed.

These values are used to compute flash flood guidance and to supply current conditions to event models and local flood warning systems. A curve is determined for each desired duration of flash flood guidance. Curves are available for 1, 3, 6, 12 and 24 hour durations. The rainfall-runoff curves and state variables from this Operation are written to the Preprocessor Parametric Data Base as parameter type FFG.

The snow and soil moisture conditions representing the area are obtained from previous Operations in the Segment. The snow and rainfall-runoff Operations are used to update the initial conditions from the carryover date to the current time. The current time conditions are those used by the Flash Flood Guidance System (FFGS).

Within Operation FFG the snow model (if selected) and the appropriate rainfall-runoff model are run for several time steps to generate rainfall-runoff curves. The curves are always generated for the 1, 3 and 6 hour durations and are generated optionally for the 12 and 24 hour durations. Each curve consists of four points which must cover a range to include any threshold runoff values defined in the FFGS. The rainfall corresponding to the minimum runoff for a 1 hour duration is the minimum point for a set of curves. The rainfall corresponding to the maximum amount of runoff for the maximum duration is the maximum point for a set of curves. The minimum and maximum rainfall values are obtained iteratively using a bisection technique. The default minimum runoff is 0.10 inch and the maximum is 2.50 inches. The user can specify minimum and maximum runoff amounts if the defaults are not suitable for a particular area. After the end points and two additional points at 30 and 60 percent of the rainfall range are established, the four corresponding runoff amounts are computed for each duration. The points of these curves and the current state variables for the Mean Areal Precipitation (MAP) area are stored in the Preprocessor Parametric Data Base for access by the FFGS.

The computation of gridded flash flood guidance in the Flash Flood Guidance System requires information relating MAPs to HRAP bins. This relationship is determined when a basin boundary is defined where the HRAP bins inside the boundary are computed and stored as parameters. In areas where predetermined weights are used to compute MAPs basin boundary definitions are not required. However gridded flash flood guidance algorithm requires basin boundary definitions

regardless of the methods used to compute MAPs.

A summary of the features of this Operation are:

1. Rainfall-runoff curves for current soil moisture conditions are computed for 1, 3 and 6 hour durations with 12 and 24 hour durations optional.
2. Rainfall-runoff models in OFS that can be used are as follows:
 - a. Sacramento Soil Moisture Accounting (SAC-SMA)
 - b. Continuous Incremental Antecedent Precipitation Index (API-CONT)
 - c. Ohio RFC Event Antecedent Precipitation Index (API-CIN)
 - d. Middle Atlantic RFC Event Antecedent Precipitation Index (API-HAR)
 - e. Missouri Basin RFC Event Antecedent Precipitation Index (API-MKC)
 - f. Northeast RFC Event Antecedent Precipitation Index (API-HFD)
3. The effect of snow can be included (SNOW-17).

A complete description of this Operation is in Section II.9.

Allowable Data Time Intervals: 1, 2, 3, 4, 6, 8, 12 and 24 hours

Time Series Required: All time series used by this Operation are obtained through reference Operations. No unique time series are used.

Input Summary: The card input for this Operation is as follows:

<u>Card</u>	<u>Field</u>	<u>Format</u>	<u>Columns</u>	<u>Contents</u>
1	1	2A4,1X	1-8	Flash flood guidance area identifier
	2	5A4,5X	10-29	Description
	3	I1,1X	35	Duration flag: 0 = only use 1, 3 and 6 hour durations 1 = include 12 hour duration 2 = include 12 and 24 hour duration
	4	F4.2,1X	37-40	Minimum threshold runoff used to compute rainfall-runoff curve; range 0.05 to 3.00 inches; default is 0.10 inch <u>1</u> /
	5	F4.2	42-45	Maximum threshold runoff used to compute rainfall-runoff curves;

<u>Card</u>	<u>Field</u>	<u>Format</u>	<u>Columns</u>	<u>Contents</u>
				range 2.00 to 10.00 inches; default is 2.50 inches <u>1/</u>
2	1	2A4,1X	1-8	Basin boundary identifier (parameter type BASN); should be associated with the same MAP or MAPX time series as the snow or rainfall-runoff model
	2	2A4,2X	10-18	Operation identifier for rainfall-runoff Operation
	3	2A4,2X	20-28	Operation name for rainfall-runoff Operation; rainfall-runoff Operation must be in this Segment
	4	2A4,2X	30-38	Operation identifier for snow Operation; default is snow Operation not used
	5	2A4,2X	40-48	Operation name for snow Operation, if used; snow Operation must be in this Segment

Note:

1/ Valid minimum and maximum amounts must be specified in both field 4 and field 5, respectively, to override the default values.

Sample Input and Output: Sample input is shown in Figure 1. Sample output from the parameter print routine is shown in Figure 2. The output from the execution routine is 'Completed FFG for id'. Figure 3 shows how the Operation names for the rainfall-runoff and snow Operations must match the rainfall-runoff and snow Operation names used in the Segment.

Error Messages: The error and warning messages generated by this Operation and the corrective action to take when they occur are as follows:

A. Messages during setup

1. ****ERROR**** INVALID MINIMUM (X.XX) AND/OR MAXIMUM (XX.XX) THRESHOLD RUNOFF RANGE.

Action: VALID MINIMUM RUNOFF RANGE: 0.05 TO 3.00
VALID MAXIMUM RUNOFF RANGE: 2.00 TO 10.00

2. ****ERROR**** ILLEGAL OPERATION TYPE FOR RAINFALL-RUNOFF MODEL: XXXXXXXX DOES NOT EXIST.

Action: Valid Operation types are API-CONT, API-CIN, API-HAR, API-MKC and SAC-SMA.

3. **ERROR** ILLEGAL OPERATION NAME FOR RAINFALL-RUNOFF MODEL:
XXXXXXXX IS NOT IN THIS SEGMENT.

Action: Operation name not defined previously in the Segment
or wrong name being used. Use correct name.

4. *ERROR** ILLEGAL OPERATION TYPE FOR RAINFALL-RUNOFF MODEL:
XXXXXXXX IS NOT ALLOWED IN THIS OPERATION.

Action: Valid Operation types are API-CONT, API-CIN, API-HAR,
API-MKC and SAC-SMA.

5. **ERROR** ILLEGAL OPERATION TYPE FOR SNOW MODEL: XXXXXXXX

Action: Valid Operation type for snow model is SNOW-17.

6. **ERROR** ILLEGAL OPERATION NAME FOR SNOW MODEL: XXXXXXXX IS
NOT IN THIS SEGMENT.

Action: Operation name not defined previously in the Segment
or wrong name being used. Use correct name.

7. **WARNING** XXXX TYPE TIME SERIES FOR ID (MAP OR MAPX ID
DEFINED IN BASIN BOUNDARY) YYYYYYYY DOES NOT MATCH TIME
SERIES ID FOR SNOW MODEL ZZZZZZZZ.

8. **ERROR** INVALID DATA TYPE FOR SNOW MODEL: XXXX.

Action: Only MAP or MAPX data types are acceptable.

9. **WARNING** XXXX TYPE TIME SERIES FOR ID (MAP OR MAPX ID
DEFINED IN BASIN BOUNDARY) YYYYYYYY DOES NOT MATCH TIME
SERIES ID FOR RAINFALL-RUNOFF MODEL ZZZZZZZZ.

10. **ERROR** INVALID DATA TYPE FOR RAINFALL-RUNOFF MODEL: XXXX.

Action: Only MAP or MAPX data types are acceptable.

11. **ERROR** NOT ENOUGH ROOM TO STORE THE FLASH FLOOD GUIDANCE
PARAMETERS.

Action: Contact your Focal Point.

12. **ERROR** NOT ENOUGH ROOM TO UPDATE THE FLASH FLOOD GUIDANCE
PARAMETERS.

Action: Contact your Focal Point.

13. **ERROR** ERROR ENCOUNTERED WHILE READING DATA IN FCPIN32.

Action: Contact your Focal Point.

Punched Card Image Rules: The following rules are when punching input
card images for this Operation:

1. The format of the punched card images is identical to those described in the Input Card Image Summary of this documentation.
2. No checks for the validity of the parametric data are made during the punching process.

Figure 1. Sample card input for Operation FFG

```

      10      20      30      40      50      60      70
-----+-----+-----+-----+-----+-----+-----+-----+-----+
FFG          DRGSWLWR
DRGSWLWR DURANGO LOWER          0 .10 2.0
DRGSWLWR API-CONT DRGSWLWR SNOW-17 DRGSWLWR

```

Figure 2. Sample output from Operation FFG print parameter routine

```

*****
FFG      OPERATION      NAME=DRGSWLWR      PREVIOUS NAME=
*****
      FFG ID: DRGSWLWR      DESC: DURANGO LOWER      IDUR: 0

      MINIMUM THRESHOLD RUNOFF: 0.10
      MAXIMUM THRESHOLD RUNOFF: 2.00

      BASIN      RAINFALL-RUNOFF MODEL      SNOW MODEL
      BNDRY ID      OP TYPE      OP NAME      OP TYPE      OP NAME
      -----      -----      -----      -----      -----
      DRGSWLWR      API-CONT      DRGSWLWR      SNOW-17      DRGSWLWR

```

Figure 3. Sample card input for multiple FFG Operations

```

              - Column -
      5      10      15      20      25      30      35      40      45      50      55      60      65      70      75      80
-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+ FFG
      ABCM4UPR
ABCM4UPR Upper Basin          0  50 350
ABCM4UPR SAC-SMA  UPR          SNOW-17  UPR
      .
      .
      .
FFG          ABCM4LWR
ABCM4LWR Lower Basin          0  50 350
ABCM4LWR SAC-SMA  LWR          SNOW-17  LWR

```