V.3.3-LAG/K LAG AND K ROUTING OPERATION

Identifier: LAG/K

Application: All programs

Description: This Operation is based on a procedure originally
developed as a graphical routing technique [Linsley, Kohler, and
Paulhus, 1975, section 9.9]. Lag and K can be used either to route
for a reach or at a point. Computations at a point can be used to
account for attenuation in the channel system above a headwater gage.

A complete description of this Operation is in Chapter II.4-LAG/K.

Reference: Linsley, R.K., Kohler, M.A., and Paulhus, J.L.H. 1975:
Hydrology for Engineers, 2nd Ed. McGraw Hill Book Company, New York.

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

Time Series Used: Time series used in this Operation are as follows:

General Type	Dimn	Units	Use	Required	Form of Output T.S.	Data Time Interval	Missing Values Allowed
Inflow/Outflow	L3/T	CMS	I/O	yes	replaces	any	no
or							
Inflow	L3	CMSD	I	yes	n/a	any	no
Outflow	L3/T	CMS	O	1/	additive	2/	yes

1/ Rules for the outflow time series are:
    o if the outflow time series is not specified the inflow time
       series will be overwritten with results from the LAG/K
       Operation
    o if the inflow time series has dimension L3 a second time
       series must be specified

2/ Any data time interval greater than or equal to the data time
   interval of the inflow time series.

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

Card	Format	Columns	Contents
1	2A4	1-8	Internal identifier of the inflow time series

Card	Format	Columns	Contents
	1X,A4	10-13	Data type code of the inflow time series
	1X,I2	15-16	Data time interval of the inflow time series (HR) See notes $\underline{1}$/, $\underline{2}$/ and $\underline{3}$/.
	1X,2A4	18-25	Internal identifier of the outflow time series
	1X,A4	27-30	Data type code of the outflow time series
	1X,I2	32-33	Data time interval of the outflow time series (HR)
	1X,I5	35-39	If > 0 - number of pairs of Lag and Q values used to define the variable Lag vs Q curve If = 0 - constant lag will be used
	1X,I5	41-45	If > 0 - number of pairs of K and Q values used to define the variable K vs Q curve If = 0 - constant K will be used

	1X,A4	47-50	Code specifying whether units of parameter and initial carryover values are English or metric:
			    'ENGL' = enter flow in CFS and
			                volume in CFSD,
			    'METR' = enter flow in CMS and
			                volume in CMSD,
			Default is metric.

	F5.0	51-55	Transmission loss recession coefficient (TLRC) for the Ft. Worth transmission loss computations. Valid range is greater than zero and less than 1. The transmission loss computations are not done if TLRC is zero.
	F10.0	56-65	The flow above which Fort Worth transmission loss computations are done. Valid range is greater than or equal to zero.
2	free real $\underline{4}$/	1-72	If the number of pairs of Lag and Q values from card 1 is greater than zero, this card contains the Lag and Q values in order Lag(1), Q(1), Lag(2), Q(2), etc. Discharges must be in ascending order. The Lag value for the smallest Q will be held constant for all lower Q's.

Card	Format	Columns	Contents

The lag value for the largest Q will be held for all higher Q's. Q = 0 or Q equal a very large flow need not necessarily be entered.

If the number of pairs of Lag and Q values from card 1 is equal to zero, this card contains one value which is the constant lag. A constant lag of zero will turn off the lag option.

3 free real 4/ 1-72   If the number of pairs of K and Q values from card 1 is greater than zero, this card contains the K and Q values in order K(1), Q(1), K(2), Q(2), etc. Discharge must be in ascending order. K values for the smallest and largest Q's are used for all flows below and above those in the table, respectively, as with the lag vs. Q table.

If the number of pairs of K and Q values from card 1 is equal to zero, this card contains one value which is the constant K. A constant K of zero will turn off the K option.

4 free int 5/ 1-72   A single integer value which specifies if carryover values will be read in. If this value equals zero, all carryover will be defaulted to zero and there are no additional cards read by this Operation. If this value is greater than zero and:
  a. Lag option is turned on - this value is the number of pairs of Q and time carryover values to be read in on card 5. The maximum number of pairs of Q and time values is equal to:

$$\frac{(largest\ lag) + 2.}{(inflow\ \Delta t)}$$

  b. Lag option is not turned on and K option is turned on - this value indicates that only K carryover will be read on card 6.

5 free real 4/ 1-72   If Lag option is turned on, this card contains pairs of Q and time carryover values in order Q(1), T(1), Q(2), T(2), etc. Time is entered as hours relative

                                  to the carryover date.

                                  If the Lag option is turned off, skip
                                  this card.

  6   free real 4/ 1-72   If K option is turned on and the inflow
                                  time series has dimensions L3/T, this
                                  card contains three values which are:
                                      a. inflow for the beginning of the
                                          routing interval
                                      b. outflow for the beginning of the
                                          routing interval
                                      c. storage for the beginning of the
                                          routing interval

                                  If K option is turned on and the inflow
                                  time series has dimensions L3, this card
                                  contains two values which are:
                                      a. outflow for the beginning of the
                                          routing interval
                                      b. storage for the beginning of the
                                          routing interval.

                                  If K option is turned off, this card
                                  contains one value which is the outflow
                                  for the beginning of the routing
                                  interval.

Notes:

1/ If LAG/K is being applied at a point (i.e., if the outflow is to
    be overwritten on the inflow time series) leave columns 18-33
    blank.

2/ If the inflow time series has dimensions L3, the Lag portion of
    this Operation cannot be enabled since it is not possible to
    correctly lag period averaged flow. Only attenuation computations
    can be performed with period averaged inflow. Instantaneous
    outflow will be produced. If some lag is required, a second LAG/K
     Operation can be used to lag the attenuated flow.

3/ If LAG/K is being used within a single reservoir Operation, enter
    'RES-SNGL' on card 1 in columns 1 through 8, 'QINE' in columns 10
    through 13 and leave columns 15 through 33 blank. If QINE is not
    entered in gage 1, mean flow routing is assumed and two LAG/K
    Operations will be needed to do both LAG and K.

4/ Real values are read in free format with the following rules:
       1. Real values must be separated by at least one blank.
       2. If an 'X' is encountered, decoding is stopped on the current
           card and the next card is read as a continuation.
       3. No characters except digits (0-9), minus sign (-), decimal
           point (.) and 'X' are allowed.

<u>5</u>/ Integer values are read in free format with the following rules:
1. Integer values must be separated by at least one blank.
2. If an 'X' is encountered, decoding is stopped on the current card and the next card is read as a continuation.
3. No characters except digits (0-9), minus sign (-) and 'X' are allowed.

<u>Sample Input and Output</u>: Sample input is shown in Figure 1. Sample output from the parameter print and carryover print routines is shown in Figure 2. There is no output from the execution routine.

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

A. Messages that can occur during setup.

1. **ERROR** INVALID DIMENSIONS (xxxx) FOR INFLOW TIME SERIES. VALID DIMENSIONS ARE L3/T AND L3.

    Action: Specify an inflow time series with valid dimensions.

2. **ERROR** CANNOT USE PERIOD AVERAGE INFLOW WITH MCP2 ATTENUATION (K) TECHNIQUE

    Action: Call your Focal Point.

3. **ERROR** CANNOT WRITE OUTFLOW TIME SERIES OVER INFLOW TIME SERIES WHEN INFLOW IS PERIOD AVERAGED.

    Action: Provide an outflow time series with dimensions L3/T.

4. **ERROR** DIMENSIONS FOR OUTFLOW TIME SERIES (xxxx) MUST BE L3/T.

    Action: Make the dimensions of the outflow time series L3/T.

5. **ERROR** INFLOW TIME STEP (nn) MUST NOT BE GREATER THAN THE OUTFLOW TIME STEP (nn).

    Action: Specify the outflow time step to be greater than or equal to the inflow time step.

6. **ERROR** NUMBER OF PAIRS OF VALUES IN THE (LAG,Q) TABLE (nnnnn) OR (K,Q) TABLE (nnnnn) MAY NOT BE LESS THAN ZERO.

    Action: Specify the number of pairs of values in both tables to be greater than or equal to zero.

7. **ERROR** DIMENSIONS FOR INFLOW TIME SERIES (xxxx) MUST BE L3/T.

    Action: Provide an inflow time series to the Lag Operation with dimensions L3/T.

8. **WARNING** CONSTANT K VALUE READ IN (nn.nnnn) IS LESS THAN
    ONE HALF OF THE COMPUTATIONAL INTERVAL. THE CONSTANT K VALUE
    HAS BEEN SET TO XX.XXXX.

    Action: Make certain that the value set for constant K is
    acceptable. To speed future setups of this segment change the
    constant K value to the value set in the above message.

9. **WARNING** VARIABLE K FOR PAIR nnnn IN THE K VS Q TABLE HAS
    BEEN RESET TO nnnn.nn. THIS VALUE CANNOT BE LESS THAN ONE
    HALF THE ROUTING INTERVAL WHEN PERIOD AVERAGE FLOW IS INPUT.

    Action: To speed future setups of this segment change the
    variable K indicated to at least one half of the routing
    interval.

10. **ERROR** DEFAULT CARRYOVER FLAG (nn) CANNOT BE LESS THAN
    ZERO.

    Action: Specify the default carryover flag to be greater than
    or equal to zero.

11. **ERROR** NUMBER OF LAG CARRYOVER VALUES (nnnnn) MUST BE
    GREATER THAN ZERO AND LESS THAN OR EQUAL TO nnnnn.

    Action: Change the number of Lag carryover values to be
    within the range specified in the error message. This range
    is the maximum number of pairs of Q and time carryover values
    which can be read in. Fewer pairs than the maximum may be
    read in. The remainder of the carryover values will be set at
    zero.

12. **WARNING** ENGLISH/METRIC INDICATOR (xxx) MUST BE 'METR',
    'ENGL' OR BLANK. METRIC IS ASSUMED.

    Action: Set English/metric switch as appropriate.

13. **WARNING** VALUE OF THE RECESSION COEFFICIENT FOR FT. WORTH
    TRANSMISSION LOSS COMPUTATIONS (nnn.n) CANNOT BE LESS THAN
    ZERO OR GREATER THAN ONE. VALUE WILL BE SET TO ZERO.

    Action: Be sure that zero is the value intended for this
    parameter. If not, change input and redefine the segment.

14. **WARNING** MINIMUM FLOW ENTERED FOR THE FT. WORTH
    TRANSMISSION COMPUTATIONS (nnnn.n) CANNOT BE LESS THAN ZERO.
    VALUE WILL BE SET TO ZERO.

    Action: Be sure that zero is the value intended for this
    parameter. If not, change input and redefine the segment.

15. **ERROR** DISCHARGES IN THE LAG VS Q TABLE MUST BE IN
    ASCENDING ORDER.

    Action: Check discharges to be sure that all flows are
    increasing.

16. **ERROR** DISCHARGES IN THE K VS Q TABLE MUST BE IN ASCENDING ORDER.

    Action: Check discharge to be sure that all flows are increasing.

B. Messages that can occur during execution.

    1. **ERROR** ATTEMPT TO WRITE BEYOND THE END OF THE QT ARRAY.

        Action: If no error in Lag/K parameters can be found, call your Focal Point

    2. **ERROR** ATTEMPT TO WRITE BEYOND THE END OF THE C ARRAY.

        Action: If no error in Lag/K parameters can be found, call your Focal Point.

    3. **WARNING** IN SUBROUTINE KA7, THE VALUE OF S20DT HAS GONE BELOW -0.5 XXXXX TIMES. THIS INDICATES A POSSIBLE ERROR IN THE LAG/K PARAMETERS.

        Action: If no error in the variable K table or other parameters can be found, call your Focal Point.

Carryover Transfer Rules: The following rules apply during the carryover transfer process:

1. The Lag carryover values of Q and time are lagged backwards with the old variable lag table (or constant lag value), then lagged forward with the new variable lag table (or constant lag value). Any values which fall before the carryover save time are lost. Any values which fall after the carryover save time are retained as new carryover.

2. If the inflow time series for the old and new parameters both have dimensions L3/T, the values of current inflow, outflow, and storage are unchanged.

3. If the old inflow time series has dimensions L3/T and the new inflow time series has dimensions L3, the current outflow and storage are unchanged. In this case current inflow is not used.

4. If the old inflow time series has dimensions L3 and the new inflow time series has dimensions L3/T, the current outflow and storage are unchanged and the current inflow is set equal to the current outflow.

Punched Card Limitations: All data read in free format are punched by subroutines that produce cards which can be read in free format. The accuracy of all real values is F15.3. If the number is greater than 10**7, the real values are punched with a F15.0 format.

Figure 1. Sample Card Input For Operation LAG/K

```
                                    - Column -
     5   10   15   20   25   30   35   40   45   50   55   60   65   70   75   80
----+----+----+----+----+----+----+----+----+----+----+----+----+----+----+----+
ROSSE    QINE  3 BLASE     SQIN  3    5    0
   10.000      0.0      12.000   300.000    18.000    750.000                X
   18.000   900.000    12.000  1350.000
    0.0
    0
```

Figure 2. Sample Output From Operation LAG/K Print Parameter And
          Print Carryover Routines

```
        LAG AND/OR K OPERATION
            COMPUTATIONAL TIME INTERVAL IS  3 HOURS.
              TIME SERIES USED BY THIS OPERATION.
                I.D.         TYPE      TIME INTERVAL
               ROSSE         QINE        3 HOURS
               BLASE         SQIN        3 HOURS

            NO FORT WORTH RFC TRANSMISSION LOSS COMPUTATIONS WILL BE DONE.

            LAG OPERATION WILL BE PERFORMED.
            A VARIABLE LAG WILL BE APPLIED.
            THE VARIABLE LAG TABLE CONTAINING   5 PAIRS OF LAG AND Q VALUES IS
            LAG (HOURS)       10.       12.       18.       18.       12.
            Q   (CMS)          .0     300.0     750.0     900.0    1350.0

            K OPERATION WILL NOT BE PERFORMED.

        LAG AND/OR K CARRYOVER VALUES.
            LAG CARRYOVER HAS BEEN SET TO A DEFAULT VALUE OF ZERO.
```