V.3.3-RES-SNGL  SINGLE RESERVOIR REGULATION OPERATION

**Identifier:** RES-SNGL

**Application:** All programs

**Description:** This Operation provides capabilities for simulating the regulation of a single, independently operated reservoir allowing operating modes to change under varying hydrologic conditions.

A complete description of the Operation is in Chapter II.4.

The manner in which releases from the reservoir are made (the operating mode) is called a Scheme. Schemes calculate discharges, pool elevations and storage contents.

Data management aids that do not compute discharges but help in controlling the simulation are called Utilities.

Table 1 describes each Scheme and Utility.

The change from one operating mode to another is specified through a set of commands called the Reservoir Control Language (RCL).

**Input Summary:** The input for this Operation is in 3 sections:

- **GENERAL** - specify the parameters, time series information and carryover values
- **SPECIFIC** - specify input for each Scheme and Utility
- **RCL** - specify the controlling statements

Each input section is opened with a section identifier and closed with an appropriate section trailer. The sections can be entered in any order but are processed in the order GENERAL, SPECIFIC and RCL.

The input uses the free format rules described in Chapter I.3-FREEFMT-UFIELD.

Abbreviations for any header, trailer or keyword are indicated by underscores beneath the letters comprising the abbreviation. For example the abbreviation for **PARMS** is **P**.

Optional keywords are indicated by brackets ([ ]). Default values are set for a keyword if it is not specified. The default values for optional keywords are provided with the keyword.

Standard units for input values are:
Units of input are set in the general section using the UNITS keyword. ACFT stands for acre-feet and TIMD is time interval mean discharge. For example an Operation data time interval of 6 hours would lead to a TIMD of 1/4 CFSD and a time interval of 12 hours would need a TIMD of 1/2 CFSD.

Examples

Example 1

In this simple example the reservoir is specified to pass inflow only. No SPECIFIC input is needed to define the pass inflow (PASSFLOW) Scheme so the only sections needed for definition are GENERAL and RCL. Any keywords that can be defaulted (noted with an *) have been supplied with values. The only model results that are to be passed from this Operation are mean discharge. The Operation time interval is 6 hours as indicated by the two inflow time series time intervals.

```
RES-SNGL    EXAMPLE1
$ GENERAL
  * UNITS ENGLISH ACFT
  * TITLE 'RES-SNGL EXAMPLE #1'
$ PARMS
  ELVSSTOR  150.0  160.0 162.5  165.0  167.5  170.0  &
         0.0   1000.0  1500.  2500.  3500.  4800.
  * INTERP LINEAR
ENDP
$ TS
  INSTQIN   EX1IN  QINE 6
  MEANQOUT EX1IN  SQME 6
  MEANQOUT EX1OUT SQME 6
ENDT
$ CO
  INFLOW    600.
  Q-INST    600.
  * Q-MEAN   600.
  * POOL1    163.3
  * POOL0    163.3
  * STORAGE  2600.
ENDCO
ENDGENL
$
RCL
  DO PASSFLOW
ENDRCL
END
```
Example 2

In this example no regulation simulation is performed. The discharge values are provided by the operating agency and supplied through a time series.

All keywords that can be defaulted have been with the result that the input units are English (with acre-feet for storage values), the interpolation used with the elevation versus storage curve is linear, the title is left blank and the missing value option for the prescribed discharge Scheme (SETQ) is specified to pass inflow.

All model outputs are to be written to a time series except for the storage contents. The Operation data time interval is 6 hours as specified by the two inflow time series data time intervals.

RES-SNGL EXAMPLE2
$
GENERAL
PARMS
  ELVSSTOR  150.0  160.0  162.5  165.0  167.5  170.0 &
  0.0  1000.  1500.  2500.  3500.  4000.
ENDP
$
TIME-SERIES
  INSTQIN  EX2IN  SQIN  6
  MEANQIN  EX2IN  SQME  6
  MEANQOUT EX2OUT  SQME  6
  INSTQOUT EX2OUT  SQIN  6
  POOL    EX2OUT  SPEL  6
ENDTS
$
CARRYOVER
  INFLOW  600.
  Q-MEAN  550.
  POOL1  163.3
ENDC
ENDDGENL
$
SPECIFIC
SETQ
PARMS
  QVALUE  TS
ENDP
$
$ TS
  SQTS EX2  RQME  6
ENDT
ENDSETQ
ENDSPEC
$
RCL
  DO SETQ
ENDRCL
END
Example 3

In this example the reservoir's regulation plan specifies to pass inflow unless either the instantaneous discharge exceeds 65000 CFS or the pool elevation surpasses 109.0 FT. With either threshold crossed, the gated spillway comes into play. The discharge and elevation checks need to be made at the beginning of each time period and after the pass inflow Scheme (PASSFLOW) if it has been executed.

Also in this example, the user wants to use observed mean discharges and observed pool elevations to adjust the model outputs. The adjusted instantaneous and mean discharges and the adjusted pool elevations are to be written to a time series. The ADJUST Utility is one of the Utilities that needs to be defined in the SPECIFIC section but needs no RCL statement to be executed.

The Operation time interval is 6 hours as set by the two inflow time series specified in the GENERAL time series section. All simulated model outputs are to be written to time series (the last 4 time series specifications in the GENERAL time series section).

RES-SNGL EX3

$ GENERAL
TITLE 'RES-SNGL EXAMPLE #3'
UNITS ENGLISH TIMD
$ PARMS
ELVSSTOR 75.0 100.0 109.0 110.0 115.0 &
118.0 120.0 122.0 125.0 &
0.0 7500. 22750. 26250. &
57500. 88750. 115000 145750. 200000.
INTERP LOG ENDP
$ TIME-SERIES
INSTQIN EX3IN QINE 6
MEANQIN EX3IN SQME 6
MEANQOUT EX3OUT SQME 6
INSTQOUT EX3OUT SQIN 6
POOL EX3OUT SPEL 6
STORAGE EX3OUT SRSO 6 ENDT
$ CARRYOVER
INFLOW 37000.
Q-INST 38000.
POOL1 109.0 ENDC
ENDGENL
$ SPECIFIC
SPILLWAY
PARMS
TYPE GATED
Example 4

In this example the selection of minimum outputs Utility (SETMIN) is used for the non-flood periods to ensure that the mean discharge from the reservoir does not exceed allowed limits. For non-flood periods, two Schemes, prescribed discharge (SETQ) and downstream stage and pool controlled discharge (STPOOLQ), are used, with the limiting discharge relations of STPOOLQ controlling the model outputs.

The occurrence of a flood situation is detected by the entry into surcharge (ENTERISC) Utility with the discharge in these flood periods determined by the induced surcharge (INDSRCHGE) Scheme.

Also in this example, the 'observed' inflow is to be back-computed using observed mean daily discharges and observed pool elevations in the BACKFLOW Utility, the model outputs are to be adjusted using observed period mean discharges and observed pool elevations in the ADJUST Utility and, since a rule curve is used in INDSRCHGE, the rule curve adjustment (RULEADJ) Utility is used to determine and apply the difference between the specified rule elevation and the elevation maintained by the operator.

The referback feature of curve definition has been used in the RULEADJ Utility definition. The rule curve is originally defined in the INDSRCHGE Scheme.
Once again the time interval is 6 hours as specified by the inflow time series in the GENERAL section.

For brevity, only subsets of the complete elevation vs storage, induced surcharge and gate rating curves will be provided in the example.

RES-SNGL   EXAMPLE4
$
GENERAL
  TITLE  'RES-SNGL EXAMPLE #4'
  UNITS  ENGLISH ACFT
  PARMS
    ELVSSTOR  560.  610.  625.  630.  635  640.  &
    0.0  168000.  365000.  463000  579000.  715000.
    INTERP LINEAR
  ENDP
TIME-SERIES
  INSTQIN  EX4IN  SQIN  6
  MEANQIN  EX4IN  SQME  6
  MEANQOUT EX4OUT SQME  6
  INSTQOUT EX4OUT SQIN  6
  POOL    EX4OUT SPEL  6
ENDT
$
CARRYOVER
  INFLOW  2900.
  Q-MEAN  675.
  POOL1  630.
ENDC
ENDDIS
$
SPECIFIC
SETQ
  PARMS
    QVALUE  TS
    OPTION  4
  ENDP
$
TS
  SQTS  EX4  RQME  6
ENDT
$
CO
  OLDQ  675.  675.  675.  675.
ENDCO
ENDS
$
BACKFLOW
TS
  OBSH  EX4  PELV  6
  OBSQ  EX4  RQME  24
ENDTS
ENDBACK
$
ADJUST
TS
OBSQOM  EX4  RQME  6
ADJQOM  EX4  RQMP  6
ADJQO   EX4  QINE  6
OBSH    EX4  PELV  6
ADJH    EX4  PELE  6
ENDT
ENDADJ
$
IndsRchge
PARMS
Hupper  635.
Hcheck Rule
Hlower  Rule
Compinq  3
IOptnd  1
SCQI   20000.  80000.  16000.  300000.
SCEL   625.5  633.2  635.  641.
SCQO   18000.  18000.  18000.  26000. &
      18000.  18000.  26000.  26000. &
      18000.  31500.  40000.  265000. &
      43000.  72000.  89000.  280000.
Dtype  3
Dtable  600.0  5 &
       635.0  7
Htarget1  635.0
Reduce   2000.
Qtarget2  18000.
Diffqi3  5000.
Gateopen  0.  4.  10.  16.
GateL   620.  628.  633.  641.
GateQ   19000. 19000. 19000. 19000. &
        42260. 46230. 48430. 51260. &
        110640. 130880. 141850. 157610. &
        293950. 293950. 293950. 330720.
GateSet  1
Curve  1  106  136  305  335  366 &
     625.  625.  635.  635.  625.  625.
Ruletime  6
Endp
Endinds
$
Ruleadj
PARMS
Curve IndsRchge
Periods  4
ElevDiff  2.0
Maxqi  40000.
Endp
$
Ts
Elev  EX4  PELV  6
Endts
Endradj
$
Stpoolq
PARMS
GAGE1
   LAG 3
   RATING EX4
   CONTROL1  6.8  8.0  9.1  10.4  12.2 &
            20000. 17000. 14000.  10000.  4000.
   CONTROL2  8.0 10.3 12.0 15.5 17.0 17.5 18.5 &
            20000. 17000. 14000. 10000.  4000.  2000.  675.
   RISING  560.  1
   FALLING 560. -999. 635.001 &
            1    2        1
CURVE INDSRCHGE
   LAG/K
   RES-SNGL
      17.
      3.
      0
   ENDP
   $TS
   LOCAL1  EX4LOCAL  SQIN6
   ENDT
ENDSTPQ
   $SETMIN
   PARMS
      TYPE MEANQ
   ENDP
ENDSPEC
   $RCL
   DO ENTERISC
   IF (SURCHARGE) THEN DO INDSRCHGE
   ELSE DO SETQ
   DO STPOOLQ
   DO SETMIN
   ENDiF
ENDRCL
END
<table>
<thead>
<tr>
<th>Name</th>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ADJUST</td>
<td>Utility</td>
<td>Output adjustment: Modify simulated values using observed values to create an adjusted value.</td>
</tr>
<tr>
<td>BACKFLOW</td>
<td>Utility</td>
<td>Inflow adjustment: Utilize observed pool elevations and discharges to adjust simulated inflow.</td>
</tr>
<tr>
<td>ENTERISC</td>
<td>Utility</td>
<td>Entry into induced surcharge Scheme: Check to see if induced surcharge Scheme is to be used.</td>
</tr>
<tr>
<td>FILLSPILL</td>
<td>Scheme</td>
<td>Fill and spill: No discharge occurs until the pool elevation reaches a specified level. The inflow is passed until maximum discharge is reached. Routing occurs at that point.</td>
</tr>
<tr>
<td>FLASHBDS</td>
<td>Scheme</td>
<td>Flash board control: A type of uncontrolled gated spillway. Flash boards provide additional storage until elevation tops the boards and the boards flip. Requires new routing regulations as additional boards flip.</td>
</tr>
<tr>
<td>GOFLASH</td>
<td>Utility</td>
<td>Entry into flash board Scheme: Check to see if flash board Scheme is to be used.</td>
</tr>
<tr>
<td>INDSRCHGE</td>
<td>Scheme</td>
<td>Induced surcharge: Provide additional storage above normal top of pool level when used during flood situations.</td>
</tr>
<tr>
<td>MAXQ</td>
<td>Utility</td>
<td>Maximum outflow: Determine maximum possible discharge at a given pool elevation.</td>
</tr>
<tr>
<td>MINQ</td>
<td>Scheme</td>
<td>Discharge minimization: A release is determined to try to prevent flooding at a downstream location by using forecasted inflows (non-iterative solution).</td>
</tr>
<tr>
<td>PASSFLOW</td>
<td>Scheme</td>
<td>Pass inflow: None of the inflow volume is retained thereby maintaining the pool elevation.</td>
</tr>
<tr>
<td>POOLQ</td>
<td>Scheme</td>
<td>Pool elevation controlled discharge: Release is controlled only by the pool elevation.</td>
</tr>
<tr>
<td>Name</td>
<td>Type</td>
<td>Description</td>
</tr>
<tr>
<td>---------------</td>
<td>---------</td>
<td>----------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>POWERGEN</td>
<td>Scheme</td>
<td>Power generation: The generation (turbine) discharge is computed as influenced by various conditions including inflow, rule curve, minimum discharge requirement, diurnal and weekly fluctuations in generation schedules and maximum generation discharge, among others. Not to be accounted for are forecasted weather conditions and power pool activities.</td>
</tr>
<tr>
<td>RAINEVAP</td>
<td>Utility</td>
<td>Direct rainfall and/or evaporation: Add influence of meteorological inputs to changes in pool elevations.</td>
</tr>
<tr>
<td>RULEADJ</td>
<td>Utility</td>
<td>Rule curve adjustment: Determine the amount of deviation the operator keeps the pool from elevation specified by the rule curve.</td>
</tr>
<tr>
<td>RULECURVE</td>
<td>Scheme</td>
<td>Rule curve: The pool elevation is specified by a table of elevations for each day of the year and discharge is computed based on the designated elevation.</td>
</tr>
<tr>
<td>SETH</td>
<td>Scheme</td>
<td>Prescribed elevation: The elevation for the time period is specified and the discharge is computed.</td>
</tr>
<tr>
<td>SETMAX</td>
<td>Utility</td>
<td>Select maximum element: Use maximum value of already computed outputs.</td>
</tr>
<tr>
<td>SETMIN</td>
<td>Utility</td>
<td>Select minimum element: Use minimum value of already computed outputs.</td>
</tr>
<tr>
<td>SETQ</td>
<td>Scheme</td>
<td>Prescribed discharge: The discharge from the reservoir for the time period is known beforehand and the pool elevation is the only computed quantity.</td>
</tr>
<tr>
<td>SPILLWAY</td>
<td>Scheme</td>
<td>Uncontrolled spillway: No discharge occurs until the pool elevation reaches a specified level. All spilled inflow is then routed.</td>
</tr>
<tr>
<td>STPOOLQ</td>
<td>Scheme</td>
<td>Downstream stage and pool elevation controlled discharge: The reservoir release is controlled by the stage at a downstream point and the current pool elevation.</td>
</tr>
<tr>
<td>Name</td>
<td>Type</td>
<td>Description</td>
</tr>
<tr>
<td>---------</td>
<td>---------</td>
<td>-----------------------------------------------------------------------------</td>
</tr>
</tbody>
</table>
| SUMINF  | Utility | Inflow summation:  
Sum inflows over a specified time interval.  
Used in power generation and minimize discharge Schemes. |