VARIABLE REFILL CURVE GENERATOR PROGRAM

PROGRAM: VRC.EXE

INTRODUCTION. Variable Refill Curves (VRC's) are required by HYSSR when it operates the river system to meet the load using the rule curves in accordance with the Pacific Northwest Coordination Agreement (PNCA). VRC's represent the lower limit to which cyclical storage projects may be drafted during the January - July refill period for a particular water year and expect to be full by 31 July. VRC's are computed for cyclical storage projects only. Annual storage projects have no VRC and are drafted to the same operating rule curve each year then refill in accordance with the Assured Refill Curve (ARC) which is equivalent to the CRC1 at annual storage projects. (See Glossary for further definition of cyclical and annual storage projects).

VRC's are computed based on either the historical runoff volume or a forecasted runoff volume. The historical runoff volume is used unless the forecasted runoff volume is input on record code 06. (Historical runoff volumes for each project are computed from natural flows read from the TABOUT file, except for The Dalles whose historical runoff volumes for each year are coded in the program). Calculation of the VRC at a project uses that project's minimum release or power discharge requirement (whichever is greater), non-power requirements for water at-site and upstream, and water required to refill upstream storage reservoirs (both annual and cyclical). The units used for VRC's are storage content in thousand acre-feet (KAF).

INPUT. The VRC program executes in batch mode, so it requires a control file named C:\HYSSR\CONFILES\VRC.CON. This control file defines the names of the input data file, the output printer file, the Study Characteristics file, the output file containing the resulting VRC's, and the Base TABOUT file (see Glossary). A sample control file follows:

```
* C:\HYSSR\CONFILES\VRC.CON
*
* Unit 5 is the input file
* Unit 6 is the printer output file
* Unit 7 is the Study Characteristics file
* Unit 10 is the resulting VRC's file in standard HYSSR format
* Unit 13 is the resulting VRCs in a format easier for EXCEL use
* Unit 14 is the Base TABOUT file
*
* FORMAT  T4,I2,T7,A26,T34,A11,T46,A7,T54,A10,T65,I4
*
*
*UNIT FILE NAME                    FORMAT      STATUS  ACCESS  RECL
*
*
   5 C:\HYSSR\DATA\VRC93.IN       FORMATTED   OLD
   6 C:\HYSSR\DATA\VRC93.PRN      FORMATTED   UNKNOWN
   7 C:\REFILL93\STCHAR93.STY     UNFORMATTED OLD
  10 C:\HYSSR\DATA\VRC.93         FORMATTED   UNKNOWN
  13 C:\HYSSR\DATA\VRCFORM.DAT    FORMATTED   UNKNOWN
  14 C:\REFILL93\TABASE.93        UNFORMATTED OLD     DIRECT  104
```

The input data file defines the program options to be used, the forecast error to be used for each project, the Power Discharge Requirements (PDR's) for each project, any changes to project characteristics, the percent remaining runoff for each period and project, values to be used as Mica's VRC for the Arrow local method, Assured Refill Curve (ARC) values, first-year Critical Rule Curve (CRC1) values, VRC Lower Limits values, and Grand Coulee pumping diversions. All of this data is input on 80 column records using the standard HYSSR format. A sample of the input data follows the record code descriptions below.

Record Code 11: This record type defines the basic options for the run. The options are as follows:

Identifier	Definition	Default
ECC	Use the base energy content curve for computation of upstream storage to fill if lower than the VRC.	VRC
NSY	Year to start calculating VRC's. Only the last two digits of the year are required. (e.g. 67)	Req'd
NLY	Year to stop calculating VRC's. Only the last two digits of the year are required. (e.g. 77)	Req'd
STY	Depletion year for the study (e.g. 1985)	Req'd

Identifier	Definition	Default
PUN	Write VRC's to output file	Not write
FLO	Number of flow years of record for this study (50 years or 60 years)	60yrs
PD1	The Jan-Jul volume runoff at The Dalles for the first PDR level. PDR's for this level are on record code 15 when there are 3 PDR levels and record code 23 for 4 PDR levels. Values need to be in KAF.	80000 KAF
PD2	The Jan-Jul volume runoff at The Dalles for the second for the second PDR level (in KAF). PDR's for this level are on record code 14 when there are 3 PDR levels and on record code 24 for 4 PDR levels.	95000 KAF
PD3	The Jan-Jul volume runoff at The Dalles for the third PDR level (in KAF). PDR's for this level are on record code 13 when there are 3 PDR levels and on record code 25 for 4 PDR levels.	110000 KAF
PD4	The Jan-Jul volume runoff at The Dalles for the fourth PDR level (in KAF). PDR's for this level are on record code 26 when there are 4 PDR levels.	0 KAF
AOP	For AOP studies restrict Grand Coulee to 1240' in May and June. Default is no AOP which restricts May to 1240' and June to 1285'.	not AOP
DEF	Not used.	

Record Code 06: This record code defines the forecasted January through July inflow volumes in thousand acre-feet (KAF). When these volumes are input, they are used to compute a project's VRC's. When no forecasted volumes are input, the historical natural flows are used to compute the inflow volumes for a project and from these volumes the VRC's are computed.

Record Code 12: This record type defines the forecast error at 95% probability in thousand acre-feet (KAF). Data values are identified by external project number and period. The values represent 1.645 times the standard error of the forecast volume, which is the sum of inflows from forecast date through July 31. The probable forecast inflow reduced by this amount assures that 95% of the time the actual runoff will equal or exceed the reduced inflow value (95% residual). One record for each cyclical project is required.

In addition, when the Arrow local method is used, a second record code 12 for Arrow is required. This record contains the local inflow forecast error by period, has Arrow's external project number in column 10, and has a non-blank character in column 16 to signify that this data is to be used for the Arrow local method only.

Record codes 13, 14, and 15: These records contain the PDR's in CFS for each of the cyclical projects when there are three PDR levels for VRC's. The VRC program uses the higher of the input PDR, the release lower bounds (RLB) from the Study Characteristics file, or the variable RLB from Base TABOUT to compute the VRC's.

Record code 13 contains PDR's for the third (highest) PDR level (input on record code 11 as "PD3"). Any runoff volumes greater than or equal to PD3 will use the PDR's on record code 13 to develop VRC's.

Record code 14 contains PDR's for the second (middle) PDR level (input on record code 11 as "PD2"). Any runoff volumes greater than PD2 but less than PD3 will be interpolated between the PDR's on record codes 14 and 13. A straight-line interpolation method is used.

Record code 15 contains PDR's for the first (lowest) PDR level (input on record code 11 as "PD1"). Runoff volumes less than or equal to PD1 will use the PDR's on record code 15. Runoff volumes less than PD2 but greater than PD1 will be interpolated between the PDR's on record codes 14 and 15.

Record code 16: This record code defines changes to be made to a project's characteristics by its external project number. The project characteristics which may be changed are:

Identifier	Project characteristic
SUB	Storage Upper Bounds (AF)
SLB	Storage Lower Bounds (AF)
RUB	Release Upper Bounds (CFS)
RLB	Release Lower Bounds (CFS)

Record code 17: This record code is used to input the percent remaining runoff values for each period January through July. When percent remaining runoff values are not input for a project, the VRC program computes these values for each period and year based on the actual project inflow data.

In addition, when the Arrow local method is used, a second record code 17 for Arrow is required. This record contains the local percent remaining runoff values by period, has Arrow's external project number in column 10, and has a non-blank character in column 16 to signify that this data is to be used for the Arrow local method only.

Record code 18: This record is used to input the actual content to be used as Mica's VRC and written to the VRC output file. The existence of values for a particular year and period on record code 18 cause the Arrow local logic for computing VRC's to be used that year and period. Record code 18 is output from the MICATEST program.

Record code 19: This record is used to input Mica's regulated outflow for a year and period when in the previous period Mica's storage content was lower than Mica's VRC. Mica's regulated outflow is used to compute Arrow's VRC when the Arrow local method is being used. Record code 19 is output from the MICATEST program.

Record codes 23, 24, 25, and 26: These records contain the PDR's in CFS for each of the cyclical projects when there are four PDR levels for VRC's. The VRC program uses the higher of the input PDR, the release lower bounds (RLB) from the Study Characteristics file, or the variable RLB from the Base TABOUT to compute VRC's. NOTE: When there are four PDR levels they are arranged from lowest (PD1) to highest (PD4). When there are three PDR levels they are arranged from highest (PD1) to lowest (PD3).

Record code 23 contains PDR's for the first (lowest) PDR level (input on record code 11 as "PD1"). Any runoff volumes less than or equal to the first PDR level will use the PDR's on record code 23 to develop VRC's.

Record code 24 contains PDR's for the second (low-middle) PDR level (input on record code 11 as "PD2"). Any runoff volumes less than PD2 but greater than PD1 will be interpolated between the PDR's on record codes 23 and 24. A straight-line interpolation method is used.

Record code 25 contains PDR's for the third (high-middle) PDR level (input on record code 11 as "PD3"). Any runoff volumes less than PD3 but greater than PD2 will be interpolated between the PDR's on record codes 24 and 25.

Record code 26 contains PDR's for the fourth (highest) PDR level (input on record code 11 as "PD4"). Runoff volumes greater than or equal to PD4 will use the PDR's on record code 26. Runoff volumes greater than PD4 but less than PD3 will be interpolated between the PDR's on record codes 25 and 26.

Record codes 41 & 42: ARC's and CRC1s on record codes 41 and 42, respectively, over-ride the values in the Base TABOUT. These records are optional, so if no ARC's and CRC1s are input the values from Base TABOUT will be used.

Record code 49: This record contains VRC Lower Limits in KAF. For each project with VRC Lower Limits, the values are input by volume runoff level and period. These lower limits cause the calculated VRC to be raised up to the lower limit, but raising the VRC up for that period does not affect the calculation of that project's other VRCs for that year. Currently the VRC Lower Limits are only used for Steps I and II of the AOP studies.

Record code 93: This record contains the Grand Coulee pumping diversions in CFS. These values are added (pumping diversions are negative) to the natural flow values used to calculate the VRC's. The VRC program will only accept pumping diversions for Grand Coulee.

SAMPLE INPUT DATA:

```
11                  DEF         ECC         STY       80PUN        1
11                  NSY       29NLY       78
11                  PD1   110000PD2    95000PD3    80000
16       3          RLB     4000
16      10          RLB      145
12       3          JAN     1759FEB     1203MAR     1096AP1     1058
12       3          APR      999MAY      941JUN      729
12      10          JAN      620FEB      455MAR      344AP1      295
12      10          APR      295MAY      256JUN      213
17       3          JAN    97.14FEB    97.25MAR    96.58AP1    96.99
17       3          APR    94.03MAY    67.13JUN    34.74
17      10          JAN    97.07FEB    97.26MAR    96.39AP1    95.63
17      10          APR    91.22MAY    56.79JUN    24.39
13       3          JAN     4000FEB     4000MAR     4000AP1     4000
```

```
13        3          APR     4000MAY     4000JUN     4000
14        3          JAN     5500FEB     5500MAR     5500AP1     5500
14        3          APR     5500MAY     5500JUN     5500
15        3          JAN     5500FEB     5500MAR     5800AP1     5800
15        3          APR     6000MAY     6000JUN     6000
49        3        80JAN   3777.0FEB   3695.1MAR   3655.3AP1   3706.4APR   3902.8
49        3        80MAY   5319.8JUN   5869.6
49        3        95JAN   1248.1FEB   1132.3MAR    924.8AP1    914.1APR   1077.1
49        3        95MAY   2332.7JUN   4355.0
49        3       110JAN   1230.7FEB    929.6MAR    884.9AP1    889.9APR    893.7
49        3       110MAY   2671.9JUN   4810.4
```

The data listed here is not complete. It is only a sample of the records needed as input for the VRC program.

OUTPUT. The VRC program produces three output files. One file contains the resulting VRC's on HYSSR record code 63 (the "PUN" must be among the options on record code 11). There is one set of records for each year and cyclical project containing VRC's for January through July. This output file may be used directly as input to build either the TDDATA or TDMODS files. Sample VRC's on HYSSR record code 63 follow:

```
63        3         29JAN   4940.9FEB   4306.2MAR   4109.9AP1   4091.1
63        3         29APR   4087.0MAY   4149.8JUN   5318.5
63        3         30JAN   4595.1FEB   3957.8MAR   3782.0AP1   3758.8
63        3         30APR   3887.4MAY   4079.8JUN   5280.9
63        3         31JAN   5869.4FEB   5869.4MAR   5739.7AP1   5711.6
63        3         31APR   5688.8MAY   4875.1JUN   5676.8
```

Another output file is generally printed. It contains a list of the input records and error messages. It also contains a detailed output for each cyclical storage project and year whenever the number of years being run is ten or less. This output is described below and a sample follows the description.

The third output file lists the project number, the 2 digit year number and the VRCs from January through July on a single line. This file should be easier to read and use in EXCEL.

Line 1: "THE DALLES JAN1-JUL31 FORECAST - KAF"

These values are the January through July runoff volumes for The Dalles in thousand acre-feet (KAF). These runoff volumes may be forecasted runoff volumes for each year and period input on record code 06 or the historical volumes for each year which are included in the VRC program. If the historical volumes are used, the program checks the "FLO" option on record code 11 to determine if the runoff volumes should be from the 60 years of record (default) or the 50 years of record.

Line 2: "PDR LEVEL"

Based on The Dalles January through July runoff volume for each period and year, the program determines the PDR level to be used. PDR levels are based on those specified on record code 11 as PD1, PD2, PD3, and, when there are four PDR levels, PD4. PDR LEVEL 1 equals 1.00, PDR LEVEL 2 equals 2.00, PDR LEVEL 3 equals 3.00, and PDR LEVEL 4 equals 4.00. When the runoff volume lies between the PDR levels, the PDR LEVEL reflects this.

Line 3: "PROB.FORECAST INFLOW (FCT.DTE-JUL31) KAF"

These values are the summation of the project's adjusted natural flows from the forecast date through 31 July. The adjusted natural flow values are read from the Base TABOUT file and have been depleted for the current study year. If Grand Coulee has any pumping diversions they are taken out during this summation.

The values on this line are in KAF.

Line 4: "FORECAST ERROR AT 95% PROB. KAF"

These are the values input on record code 12 in KAF. The probable forecast inflow (Line 3) is reduced by these values to insure that 95% of the time the actual runoff will equal or exceed the reduced value (Line 5).

Line 5: "RESIDUAL 95% FORECAST (DATE TO JUL31) KAF"

This is the result of subtracting the forecast error at 95% probability (Line 4) from the probable forecast inflow (Line 3). These values are in KAF.

Line 6: "NORMAL INFLOW % OF VOLUME"

For each period this value is the percent of the total runoff that occurs after that period. These values are input on record code 17 or computed from actual inflow volumes when no values are input. For example, 93% represents the percentage of the Feb 1 - Jul 31 runoff that occurs after February (Mar 1 - Jul 31).

Line 7: "FORECAST INFLOW KAF"

This is the result of multiplying the residual 95% forecast volume (Line 5) by the normal inflow percent of volume (Line 6) and dividing by 100. These forecast inflow values are in KAF.

Line 8: "OUTFLOWS FOR NEXT PERIOD CFS"

These values are the greater of: the PDR's (input on record codes 13, 14, and 15 or 23, 24, 25, and 26) for the appropriate PDR level; or the project's release lower bounds (from the Study Characteristics file or record code 16); or the variable release lower bounds from Base TABOUT. These values are in CFS.

Line 9: "OUTFLOW DEPLETION DECREMENT KAF"

These values are the outflows for next period (Line 8) converted to volumes and then summed, beginning with July and summing back toward the current period. These values are in KAF.

Line 10: "UPSTREAM STORAGE KAF"

These values represent the volume of water that will need to be replaced at upstream projects. This volume reduces the water available to refill downstream projects. For cyclical projects, the required volume is either the computed VRC or the Energy Content Curve (ECC) subtracted from full for each project upstream of the

current project. The "ECC" option on record code 11 determines whether the VRC or ECC is used. A note at the bottom of the project's output indicates if the ECC was used to compute the upstream storage. For annual projects, the volume used as upstream storage at a downstream project is the difference between the project's full storage content and the CRC1 for that period.

Line 11: "NET INFLOW KAF"

This is the outflow depletion decrement (Line 9) added to the upstream storage (Line 10) and then this value is subtracted from the forecast inflow (Line 7). These values are in KAF.

Line 12: "END OF MONTH STORAGE CONTENT (VRC) KAF"

These values are the VRC's in KAF and are computed by subtracting the net inflow (Line 11) from the project's full (SUB). The VRC may not be less than the project's storage lower bounds (SLB). These are the values output to record code 63 when the "PUN" option is present on record code 11.

Line 13: "BASE ENERGY CONTENT CURVE KAF"

This is the higher of the CRC1 and the ARC for the project. The Base Energy Content Curve (BECC) is compared with the computed VRC to determine the Energy Content Curve (ECC).

Line 14: "ENERGY CONTENT CURVE KAF"

This is the lower of the BECC (line 13) and the computed VRC (usually line 12 except at Mica when the Arrow local method is used). The ECC is subtracted from project full content to determine the UPSTREAM STORAGE (line 10) for downstream projects.

Line 15: "LOWER LIMIT CURVE KAF"

This is the VRC Lower Limit for the VRC. If the computed VRC is lower than the VRC Lower Limit then the VRC for that period is raised to the VRC Lower Limit. The VRC on line 12 has had this VRC Lower Limit applied.

SPECIAL PROJECT RESTRICTIONS:

The VRC program contains special restrictions for VRC calculations at Hungry Horse and Grand Coulee. They are:

- the VRC at Hungry Horse may not be less than elevation 3475.0 feet in any period January through July.
- the VRC for May 31 at Grand Coulee may not be less than elevation 1240 feet. If Grand Coulee's VRC is computed below 1240' on May 31, the VRC is increased to 1240' and all of Grand Coulee's VRC's for January through April 30 are adjusted by the amount the May 31 value was increased. This is true for all three steps of the AOP and for PNCA.
- the VRC for June 30 at Grand Coulee may not be less than 1285 feet elevation for PNCA. If the computed VRC is less than 1285', the VRC is increased to 1285', but no adjustments are made to any other periods. No "AOP" option should be on record code 11 of the input.
- the VRC for June 30 at Grand Coulee for all three steps of the AOP is not restricted to 1285'. AOP studies must have the "AOP" option on record code 11.

PROGRAM EXECUTION ON THE PC: To execute the VRC program, have a copy of VRC.EXE in the local C:\HYSSR\PGM subdirectory and the program will execute using the datasets named in VRC.CON. This control file must be in the local C:\HYSSR\CONFILES subdirectory and changed to meet the data file naming conventions being used. The existing format of the confile may not be altered.

SAMPLE VRC OUTPUT

VARIABLE REFILL CURVE (VRC) GENERATOR PROGRAM 08/16/95

INPUT DATA

```
11                DEF        ECC        STY       90PUN        1
11                NSY      29NLY      29
11                FLO      60
11                PD1   80000PD2   95000PD3   110000
12      1         JAN    1354FEB    1093MAR    1018AP1      913
12      1         APR     913MAY     874JUN     933
12      2         JAN    2696FEB    2067MAR    1865AP1     1567
12      2         APR    1567MAY    1472JUN    1692
12      3         JAN    1759FEB    1203MAR    1096AP1     1058
12      3         APR     999MAY     941JUN     729
12      5         JAN     223FEB     194MAR     185AP1      181
12      5         APR     181MAY     168JUN     170
12     10         JAN     620FEB     455MAR     344AP1      295
12     10         APR     295MAY     256JUN     213
12     19         JAN   15249FEB   11219MAR    9743AP1     8044
12     19         APR    7283MAY    6523JUN    5889
12     31         JAN     462FEB     326MAR     250AP1      209
12     31         APR     181MAY     153JUN     108
16      3         RLB    4000
16     10         RLB     145
16      1         SLB  0.0001
17      3         JAN   97.14FEB   97.25MAR   96.58AP1   96.99
17      3         APR   94.03MAY   67.13JUN   34.74
17      5         JAN  100.00FEB   97.90MAR   97.50AP1   95.60
17      5         APR   93.80MAY   76.70JUN   46.80
17      1         JAN  100.00FEB   97.70MAR   97.50AP1   96.10
17      1         APR   94.80MAY   80.20JUN   49.50
17      2         JAN  100.00FEB   97.20MAR   97.00AP1   94.90
17      2         APR   92.90MAY   76.00JUN   45.40
17     10         JAN   97.07FEB   97.26MAR   96.39AP1   95.63
17     10         APR   91.22MAY   56.79JUN   24.39
17     19         JAN   96.21FEB   96.21MAR   94.64AP1   95.15
17     19         APR   91.67MAY   64.96JUN   37.52
17     31         JAN   94.20FEB   93.83MAR   89.52AP1   89.11
17     31         APR   83.21MAY   46.27JUN   23.40
41      3         JAN  4273.4FEB  4170.3MAR  4066.2AP1  4036.5APR  3973.0
41      3         MAY  4755.8JUN  5666.0JUL  5869.4AG1  4370.0AUG  4468.5
41      3         SEP  4537.9OCT  4531.3NOV  4474.9DEC  4374.0
41      5         JAN   560.7FEB   556.7MAR   560.1AP1   574.4APR   544.1
41      5         MAY   739.0JUN  1097.8JUL  1424.9AG1   150.6AUG   291.2
41      5         SEP   422.7OCT   483.6NOV   518.3DEC   540.5
41      1         JAN  6339.9FEB  5373.1MAR  4156.8AP1  3611.6APR  3142.5
41      1         MAY  3331.9JUN  5248.5JUL  7000.0AG1  5285.4AUG  6220.4
41      1         SEP  7000.0OCT  7000.0NOV  7000.0DEC  7000.0
41      2         JAN  1868.6FEB  2328.1MAR  2910.7AP1  3030.4APR  3217.1
41      2         MAY  4753.1JUN  6694.0JUL  7327.3AG1   227.3AUG   227.3
41      2         SEP   227.3OCT   744.5NOV  1012.8DEC  1117.8
41     10         JAN  2953.6FEB  2875.6MAR  2795.6AP1  2716.6APR  2502.8
41     10         MAY  2882.2JUN  3071.5JUL  3071.5AG1  3071.5AUG  3071.5
41     10         SEP  3071.5OCT  3071.5NOV  3071.5DEC  3063.5
41     19         JAN  6302.3FEB  5134.1MAR  3999.5AP1  3921.9APR  4112.0
41     19         MAY  4388.1JUN  8076.4JUL  9107.4AG1  4333.0AUG  5675.0
41     19         SEP  7390.2OCT  6942.4NOV  7227.2DEC  6828.2
41     31         JAN  2632.5FEB  2624.4MAR  2804.2AP1  3068.9APR  3264.7
41     31         MAY  3342.2JUN  3468.0JUL  3468.0AG1  2635.0AUG  2626.1
41     31         SEP  2615.0OCT  2629.2NOV  2659.4DEC  2657.
15      1         JAN   15000FEB   20000MAR   23000AP1   23000
15      1         APR   23000MAY   25000JUN   28000JUL   28000
15      2         JAN    5000FEB   15000MAR   18000AP1   22000
15      2         APR   30000MAY   45000JUN   50000JUL   50000
15      5         JAN     100FEB     500MAR     500AP1     500
15      5         APR    2000MAY    2000JUN    2000JUL    2000
15      3         JAN    4000FEB    4000MAR    4000AP1    4000
15      3         APR    4000MAY    4000JUN   11000JUL   11000
15     10         JAN     145FEB     145MAR     145AP1     700
15     10         APR    1000MAY    1200JUN    2000JUL    2700
15     19         JAN   30000FEB   30000MAR   30000AP1   30000
```

SAMPLE VRC OUTPUT

15	19		APR	30000MAY	120000JUN	30000JUL	30000	
15	31		JAN	2000FEB	2000MAR	2000AP1	2000	
15	31		APR	2000MAY	12000JUN	2000JUL	2000	
14	1		JAN	15000FEB	15000MAR	15000AP1	15000	
14	1		APR	10000MAY	10000JUN	20000JUL	25000	
14	2		JAN	5000FEB	5000MAR	5000AP1	5000	
14	2		APR	30000MAY	30000JUN	50000JUL	50000	
14	5		JAN	100FEB	100MAR	100AP1	500	
14	5		APR	2000MAY	2000JUN	2000JUL	2000	
14	3		JAN	4000FEB	5000MAR	5000AP1	5000	
14	3		APR	6000MAY	6000JUN	8000JUL	9000	
14	10		JAN	145FEB	145MAR	145AP1	700	
14	10		APR	1000MAY	1200JUN	2000JUL	2700	
14	19		JAN	30000FEB	30000MAR	30000AP1	30000	
14	19		APR	30000MAY	120000JUN	30000JUL	30000	
14	31		JAN	2000FEB	2000MAR	2000AP1	2000	
14	31		APR	2000MAY	12000JUN	2000JUL	2000	
13	1		JAN	15000FEB	15000MAR	15000AP1	15000	
13	1		APR	10000MAY	10000JUN	10000JUL	10000	
13	2		JAN	5000FEB	5000MAR	5000AP1	5000	
13	2		APR	20000MAY	20000JUN	35000JUL	45000	
13	5		JAN	100FEB	100MAR	100AP1	500	
13	5		APR	1500MAY	2000JUN	2000JUL	2000	
13	3		JAN	4000FEB	4000MAR	4000AP1	5000	
13	3		APR	6000MAY	6000JUN	8000JUL	9000	
13	10		JAN	145FEB	145MAR	145AP1	700	
13	10		APR	1000MAY	1200JUN	2000JUL	2700	
13	19		JAN	30000FEB	30000MAR	30000AP1	30000	
13	19		APR	30000MAY	120000JUN	30000JUL	30000	
13	31		JAN	2000FEB	2000MAR	2000AP1	2000	
13	31		APR	2000MAY	12000JUN	2000JUL	2000	
93	19		JUL	-9500AG1	-9650AUG	-6870SEP	-4685	
93	19		OCT	-2180NOV	0DEC	0JAN	0	
93	19		FEB	0MAR	-7548AP1	-10927APR	-6180	
93	19		MAY	-7240JUN	-8490			
12	2	A	JAN	2243.0FEB	1882.0MAR	1591.0AP1	1257.0	
12	2	A	APR	1239.0MAY	1102.0JUN	1105.0		
18			29JAN	1695.0FEB	595.1MAR	-134.0AP1	-515.2APR	-701.5
18			29MAY	-217.3JUN	2635.7			
19			29FEB	23000.0MAR	22000.0AP1	26296.1APR	10000.0MAY	10000.0
19			29JUN	10000.0JUL	10000.0			
18			30JAN	706.5FEB	0.0MAR	-676.6AP1	-855.9APR	-626.9
18			30MAY	233.8JUN	3091.2			
19			30FEB	23000.0MAR	19716.5AP1	8991.0APR	10000.0MAY	10000.0
19			30JUN	10000.0JUL	27000.0			
49	3		80JAN	3777.0FEB	3695.1MAR	3655.3AP1	3706.4APR	3902.8
49	3		80MAY	5319.8JUN	5869.6			
49	3		95JAN	1248.1FEB	1132.3MAR	924.8AP1	914.1APR	1077.1
49	3		95MAY	2332.7JUN	4355.0			
49	3		110JAN	1230.7FEB	929.6MAR	884.9AP1	889.9APR	893.7
49	3		110MAY	2671.9JUN	4810.4			

SAMPLE VRC OUTPUT

VRC PROGRAM PC VERSION VARIABLE REFILL CURVES (VRC) 08/16/95

INPUT DATA SUMMARY

REQUESTED OPTIONS

STARTING YEAR	1929
ENDING YEAR	1929
PDR LEVEL 1	80000. KAF
PDR LEVEL 2	95000. KAF
PDR LEVEL 3	110000. KAF

****USING RUNOFF VOLUME FROM 60 YEARS OF FLOWS

WRITE VRCS TO FILE	YES
DEPLETION YEAR	1990
AOP STUDY	NO

FORECAST ERROR AT 95% PROBABILITY (KAF)

PROJECT	NAME	JAN	FEB	MAR	AP1	APR	MAY	JUN	JUL
166	TIMOTHY	15.	13.	9.	6.	6.	6.	3.	0.
150	ROSS	600.	427.	321.	251.	226.	200.	194.	0.
157	CUSHMAN NO 1	111.	94.	66.	44.	44.	44.	44.	0.
155	ALDER	294.	250.	173.	115.	115.	115.	115.	0.
3	LIBBY	1759.	1203.	1096.	1058.	999.	941.	729.	0.
5	DUNCAN	223.	194.	185.	181.	181.	168.	170.	0.
1	MICA	1354.	1093.	1018.	913.	913.	874.	933.	0.
2	ARROW	2696.	2067.	1865.	1567.	1567.	1472.	1692.	0.
10	HUNGRY HORSE	620.	455.	344.	295.	295.	256.	213.	0.
19	GRAND COULEE	15249.	11219.	9743.	8044.	7283.	6523.	5889.	0.
20	CHELAN	403.	357.	303.	131.	129.	127.	117.	0.
21	BROWNLEE	3262.	2760.	2297.	2158.	1725.	1731.	1719.	0.
31	DWORSHAK	462.	326.	250.	209.	181.	153.	108.	0.
40	ROUND BUTTE	499.	432.	353.	283.	234.	185.	103.	0.
159	SWIFT NO 1	774.	657.	457.	303.	303.	303.	303.	0.
161	YALE	774.	657.	457.	303.	303.	303.	303.	0.
162	MERWIN	943.	801.	557.	369.	369.	369.	369.	0.
163	MOSSYROCK	1067.	907.	630.	418.	418.	418.	418.	0.

SAMPLE VRC OUTPUT

INPUT DATA SUMMARY

POWER DISCHARGE REQUIREMENTS (PDRS IN CFS)

PROJECT	NAME		JAN	FEB	MAR	AP1	APR	MAY	JUN	JUL
3	LIBBY	80 MAF	4000.	5000.	5200.	5200.	6200.	6200.	8000.	9000.
		95 MAF	4000.	5000.	5000.	5000.	6000.	6000.	8000.	9000.
		110 MAF	4000.	4000.	4000.	5000.	6000.	6000.	8000.	9000.
5	DUNCAN	80 MAF	100.	500.	500.	500.	2000.	2000.	2000.	2000.
		95 MAF	100.	100.	100.	500.	2000.	2000.	2000.	2000.
		110 MAF	100.	100.	100.	500.	1500.	2000.	2000.	2000.
1	MICA	80 MAF	15000.	20000.	23000.	23000.	23000.	25000.	28000.	28000.
		95 MAF	15000.	15000.	15000.	15000.	10000.	10000.	20000.	25000.
		110 MAF	15000.	15000.	15000.	15000.	10000.	10000.	10000.	10000.
2	ARROW	80 MAF	5000.	15000.	18000.	22000.	30000.	45000.	50000.	50000.
		95 MAF	5000.	5000.	5000.	5000.	30000.	30000.	50000.	50000.
		110 MAF	5000.	5000.	5000.	5000.	20000.	20000.	35000.	45000.
10	HUNGRY HORSE	80 MAF	145.	145.	145.	700.	1000.	1200.	2000.	2700.
		95 MAF	145.	145.	145.	700.	1000.	1200.	2000.	2700.
		110 MAF	145.	145.	145.	700.	1000.	1200.	2000.	2700.
19	GRAND COULEE	80 MAF	30000.	30000.	30000.	30000.	30000.	120000.	30000.	30000.
		95 MAF	30000.	30000.	30000.	30000.	30000.	120000.	30000.	30000.
		110 MAF	30000.	30000.	30000.	30000.	30000.	120000.	30000.	30000.
31	DWORSHAK	80 MAF	2000.	2000.	2000.	2000.	2000.	12000.	2000.	2000.
		95 MAF	2000.	2000.	2000.	2000.	2000.	12000.	2000.	2000.
		110 MAF	2000.	2000.	2000.	2000.	2000.	12000.	2000.	2000.

SAMPLE VRC OUTPUT

VARIABLE REFILL CURVE (VRC) 8/10/00

LIBBY

WATER YEAR 1929 DEPLETION YEAR 1990

FORECAST DATE	JAN	FEB	MAR	AP1	APR	MAY	JUN	JUL
THE DALLES JAN1-JUL31 FORECAST-KAF	67000.	67000.	67000.	67000.	67000.	67000.	67000.	67000.
PDR LEVEL	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

FORECAST DATE		JAN	FEB	MAR	AP1	APR	MAY	JUN
PROB.FORECAST INFLOW (FCT.DTE-JUL31)	KAF	4843.4	4707.7	4573.3	4416.9	4341.9	4206.7	3011.2
FORECAST ERROR AT 95% PROB.	KAF	1759.0	1203.0	1096.0	1058.0	999.0	941.0	729.0
RESIDUAL 95% FORECAST(DATE TO JUL31)	KAF	3084.4	3504.7	3477.3	3358.9	3342.9	3265.7	2282.2

INFLOW PERIOD		FEB1-JUL31	MAR1-JUL31	APR1-JUL31	APR16-JUL31	MAY1-JUL31	JUN1-JUL31	JUL1-JUL31
NORMAL INFLOW % OF VOLUME		97.0	97.1	96.4	97.0	93.9	66.8	35.5
FORECAST INFLOW	KAF	2990.7	3404.4	3352.8	3256.8	139.6	2183.1	809.0
OUTFLOWS FOR NEXT PERIOD	CFS	4000.0	4000.0	4000.0	4000.0	11000.0	11000.0	11000.0
OUTFLOW DEPLETION DECREMENT	KAF	2713.4	2491.2	2245.3	2126.3	2007.3	1330.9	676.4
UPSTREAM STORAGE	KAF	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NET INFLOW	KAF	277.3	913.2	1107.5	1130.5	1132.3	852.2	132.7

RULE CURVE PERIOD		JAN	FEB	MAR	AP1	APR	MAY	JUN
END OF MONTH STORAGE CONTENT (VRC)	KAF	5592.1	4956.2	4761.9	4738.9	4737.1	5319.8!	5869.4!
BASE ENERGY CONTENT CURVE	KAF	3977.0	3874.3	3770.6	3742.2	3471.8	4372.9	5869.4
ENERGY CONTENT CURVE	KAF	3977.0	3874.3	3770.6	3742.2	3471.8	4372.9	5869.4
LOWER LIMIT CURVE	KAF	3777.0	3695.1	3655.3	3706.4	3902.8	5319.8	5869.4

"*" INDICATES SLB
"!" INDICATES LIMITED BY LOWER LIMIT FROM CC 49

SUB 5869.4 KAF
SLB 889.9 KAF

UPSTREAM STORAGE WAS COMPUTED FROM ECC FOR UPSTREAM PROJECTS

SAMPLE VRC OUTPUT

VARIABLE REFILL CURVE (VRC) 08/10/00

GRAND COULEE

WATER YEAR 1929 DEPLETION YEAR 1990

FORECAST DATE	JAN	FEB	MAR	AP1	APR	MAY	JUN	JUL
THE DALLES JAN1-JUL31 FORECAST - KAF	67000.	67000.	67000.	67000.	67000.	67000.	67000.	67000.
PDR LEVEL	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

FORECAST DATE		JAN	FEB	MAR	AP1	APR	MAY	JUN
PROB.FORECAST INFLOW (FCT.DTE-JUL31)	KAF	40704.5	9434.2	38329.9	36421.6	35363.7	33643.6	23140.9
FORECAST ERROR AT 95% PROB.	KAF	15249.0	11219.0	9743.0	8044.0	8044.0	6522.0	5804.0
RESIDUAL 95% FORECAST(DATE TO JUL31)	KAF	25455.5	28215.2	28586.9	28377.6	27319.7	27121.6	17336.9

INFLOW PERIOD		FEB1-JUL31	MAR1-JUL31	APR1-JUL31	APR16-JUL31	MAY1-JUL31	JUN1-JUL31	JUL1-JUL31
NORMAL INFLOW % OF VOLUME		96.2	96.2	94.6	95.2	87.3	65.2	38.3
FORECAST INFLOW	KAF	24490.7	27145.9	27054.6	27001.3	23850.1	17683.3	6640.1
OUTFLOWS FOR NEXT PERIOD	CFS	30000.0	30000.0	30000.0	30000.0	30000.0	30000.0	30000.0
OUTFLOW DEPLETION DECREMENT	KAF	10770.2	9104.1	7259.5	6366.9	5474.4	3629.8	1844.6
UPSTREAM STORAGE	KAF	12497.9	13905.5	15241.8	15015.6	14688.3	9693.1	2303.5
NET INFLOW	KAF	374.0$	3287.7$	3704.8$	4770.2$	2838.9$	3511.9	2491.9

RULE CURVE PERIOD		JAN	FEB	MAR	AP1	APR	MAY	JUN
END OF MONTH STORAGE CONTENT (VRC)	KAF	8862.3!	7576.2!	7515.8!	8059.8!	7492.5!	8196.7!	9107.3!
BASE ENERGY CONTENT CURVE	KAF	8862.0	8862.0	8570.4	8570.4	8570.4	8589.6	9107.3
ENERGY CONTENT CURVE	KAF	8862.0	7576.2	7515.8	8059.8	7492.5	8196.7	9107.3
LOWER LIMIT CURVE	KAF	8862.3	7576.2	7515.8	8059.8	7492.5	8196.7	9107.3

"*" INDICATES SLB
"!" INDICATES LIMITED BY LOWER LIMIT FROM CC 49
"$" INDICATES GRAND COULEE INFLOW RESTRICTED BY ELEVATION 1240 ON 31 MAY

FOR AOP STUDIES GCL IS NOT RESTRICTED TO ELEV 1285 ON 30 JUN

SUB 9107.4 KAF
SLB 3921.9 KAF

UPSTREAM STORAGE WAS COMPUTED FROM ECC FOR UPSTREAM PROJECTS