AD-A096 521 ARMY ENGINEER WATERWAYS EXPERIMENT STATION VICKSBURG--ETC F/G 13/2
H5320 - LOCK FILLING AND EMPTYING SYMMETRICAL SYSTEMS, PROGRAM --ETC(U)
JUN 78 F M NEILSON, M T HEBLER

UNCLASSIFIED NL

1 OF 1
AD
A096521

END
DATE
FILMED
4-81
DTIC

ELECTRONIC COMPUTER PROGRAM ABSTRACT

TITLE OF PROGRAM	PROGRAM NO.
H532Ø - Lock Filling and Emptying Symmetrical Systems	722-F3-R0-5J15

PREPARING AGENCY Hydraulic Analysis Division, Hydraulics Laboratory, U. S. Army Engineer Waterways Experiment Station, P. O. Box 631, Vicksburg, MS. 39180

AUTHOR(S)	DATE PROGRAM COMPLETED	STATUS OF PROGRAM PHASE	STAGE
Frank M. Neilson Martin T. Hebler	March 1976 Documented June 1978	Origin	Operational

A. PURPOSE OF PROGRAM

To determine the hydraulic performance of a lock culvert system.

LEVEL

DTIC
S MAR 1 1 1981
C

B. PROGRAM SPECIFICATIONS

SEE FOLLOWING PAGES.

C. METHODS

The program is written in G635 time-share series, FORTRAN IV, and is part of a Conversationally Oriented Real-Time Program-Generating System (CORPS). The program consists of a main program, three function subprograms, and six subroutines. The specific function and relation of all these routines can be found in the FUNCTIONAL FLOW CHART, PART II: COMPUTER FUNCTIONAL DESCRIPTION of this abstract.

D. EQUIPMENT DETAILS

The program was developed and is operational on the WES G635, Vicksburg, MS. It is also operational on HIS66/80, Macon, GA, and Boeing CDC, Seattle, WA.

E. INPUT-OUTPUT

All inputs for program H5320 are either read from a permanent data file or are cued and read upon entry to the input subroutine DATA F. All specific input/output requirements for program H5320 are given in PART II: COMPUTER FUNCTIONAL DESCRIPTION of this abstract.

F. ADDITIONAL REMARKS

Complete documentation of this program is available from the Engineer Computer Programs Library, Technical Information Center, WES.

81 3 9 093

ENG FORM 2883
1 AUG 60

PREVIOUS EDITIONS ARE OBSOLETE.

B. PROGRAM SPECIFICATIONS:

Language: ANSI FORTRAN (FORTRAN IV)

Solution Requirements: The run command

RUN WESLIB/CORPS/H532Ø,R

plus the necessary input data.

Method of Analysis: A finite difference scheme is used to determine the flow rate through the culverts and water surface elevation in the chamber during a lock operation.

Core Requirements G635: 21 K words.

External Storage: Type of storage - disk. A user may have an input permanent data file with a maximum of 1 K G635 ASCII words. If the user does not have an input data file, one of the same size and user named will be created during a run of this program. If a user decides to save output for graphics and/or other use, a user named output file with a maximum of 13 K G635 ASCII words will be created. If the output file exists, then the existing output file is used.

General Equation: The governing equation is:

$$(k_1 + k_2 + k_v(t) + k_3 + k_4)\frac{V(t)^2}{2g} = \varepsilon\left[Z_{ref} - z(t)\right] - \frac{L}{g}\left(\frac{dv}{dt}\right)$$

Where k_1, k_2, k_3, and k_4 = constant loss coefficient values for the intake, upstream conduit, downstream conduit, and exit manifold.

$k_v(t)$ = the valve loss coefficient which is a variable during valve opening and has a preset value of 0.1 for a full open valve

$V(t)$ = velocity of flow at a reference location in the culvert(s) at time t, fps

g = acceleration of gravity, 32.2 ft/sec^2

ε = operation type ($\varepsilon = 1$ for filling; $\varepsilon = -1$ for emptying)

Z_{ref} = upper pool elevation Z_u (filling) and lower pool elevation Z_L (emptying), ft-datum

$Z(t)$ = water-surface elevation in lock chamber at time t, ft-datum

L = culvert length, ft

$\frac{dv}{dt}$ = rate of change of velocity of water in the culvert at time t, ft/sec^2

Range of Quantities: Unlimited for practical applications.

Accuracy: Governed by accuracy of input data; the accumulative velocity error is a measure of the accuracy of the solution.

REF: ER 1110-1-10 - ENGINEERING AND DESIGN - Engineering Computer Program Library Standards and Documentation, Appendix B

PART I: ENGINEERING DESCRIPTION

1. PROGRAM NUMBER: 722-F3-RC-5J1

2. TITLE: *H5320 - Lock Filling and Emptying Symmetrical Systems*

3. REVISION LOG: N/A

4. PURPOSE OF PROGRAM: The purpose of the program is to determine the hydraulic performance of a lock culvert system. The core of the program is a finite difference scheme which is used to determine flow rate through the culverts and water-surface elevation in the chamber during a lock operation. Once these are known, other important hydraulic parameters are evaluated. The program output contains the following computed quantities.

a. Single Values.

(1) Operation time (T), min.

(2) Overtravel (d_o), ft, and time (T_m), min., of occurrence.

b. Time Dependent Values.

(3) Time (t), min.

(4) Valve opening ratio (b|B).

(5) Total inflow (Q), cfs.

(6) Velocity head (h_v), ft, at the reference area.

(7) Velocity head (h_{vv}), ft, just downstream from the valve.

(8) Water-surface elevation (z), ft-datum, in the lock chamber.

(9) Water-surface elevation (z_{uw}), ft-datum, in the upstream valve well.

(10) Water-surface elevation (z_{dw}), ft-datum, in the downstream valve well.

(11) Piezometric head (h_p), ft-datum, at the culvert roof just downstream from the valve.

(12) Cavitation index (σ).

(13) Average velocity (V), fps, in the culvert at the reference area.

(14) Rate-of-rise (d_z/d_t), ft/min., of the lock chamber water surface.

(15) Head losses ($H_{\ell 1}$, $H_{\ell 2}$, $H_{\ell v}$, $H_{\ell 3}$, $H_{\ell 4}$, and $H_{\ell T}$), ft, for culvert intake, upstream conduit, valve, downstream conduit, culvert exit, and overall culvert system(s), respectively.

(16) Effective inertia (H_e), ft, in the flow in the culvert.

(17) Overall drop ($H_t = H_{\ell 1} + H_{\ell 2} + H_{\ell v} + H_{L3} + H_{L4} + H_e$), ft, in water-surface elevation.

5. STEP SOLUTION:

a. Mathematical Formulation. The distribution of total head at an instant during a lock filling operation is assumed to be as shown in Figure 1; a comparable distribution is assumed for an emptying operation. The manner in which each item shown in Figure 1 is used in setting up the mathematical model is described in Table 1. Two simultaneous first-order differential equations are solved as a function of time (t); these equations are either equations (1a) and (2), or (1b) and (2), in the following listing.

(1) Conservation of Energy.

(a) Normal Flow

$$\frac{KV^2}{2g} = \varepsilon(Z_{ref} - z) - H_e \qquad (1a)$$

or

(b) Reverse Flow $$\frac{-KV^2}{2g} = \varepsilon(Z_{ref} - z) - H_e \qquad (1b)$$

(2) Continuity (Normal and Reverse Flows)

$$\frac{dz}{dt} = \varepsilon A_r V \qquad (2)$$

The variables in equations (1a), (1b), and (2) are as listed in Table 1 with the following exceptions:

$K = k_1 + k_2 + k_v + k_3 + k_4$; where k_v and K are known functions of time.

ε = 1 for filling
-1 for emptying

$A_r = A_L/n_c A_c$; where A_L is the surface area in the lock chamber and

dz/dt = the rate-of-change of the elevation of the chamber water surface; dz/dt is positive for a rising water level.

The only boundary conditions prescribed are those when $t = 0$,

$z = Z_L$ for filling
Z_u for emptying

$V = 0$

$K = \infty$

b. <u>Time Steps</u>. A known time (t_i) is advanced by a constant value (Δt) to a new time ($t_{i+1} = t_i + \Delta t$). Values of i that are of specific interest are listed below.

Value of i	Condition
1	Initial value (i.e., $t_i = 0.0$)

Value of i	Condition
N	Valve is fully open (i.e., $k_{i+1} = k_i$ for $i \geq N$)
M1	Lock operation is complete
	Filling: $z_{M1-1} < Z_u \leq z_{M1}$
	Emptying: $Z_{M1-1} > Z_L \geq Z_{M1}$
M2	Maximum overfill or overempty
	Filling: $Z_{M2-1} < Z_{M2} > Z_{M2+1}$
	Emptying: $Z_{M2-1} > Z_{M2} < Z_{M2+1}$
M	Final value (i.e., $t_M = (M - 1)\,\Delta t$)

Known: V_i , z_i , K_{i+1} , K_{i+2}

1st Prediction $V_{i+1} = F_p(z_i, V_i, K_{i+1})$

z_{i+1} from equation (4)

2nd Prediction: $V_{i+2} = F_p(z_{i+1}, V_{i+1}, K_{i+2})$

$$z_{i+2} = Z_{i+1} + \varepsilon \left(\frac{V_{i+2} + V_{i+1}}{2}\right) A_r \Delta t \quad \text{Iteration loop A}$$

Corrector: $V_{i+1} = F_p(z_i, V_i \text{ and } V_{i+2}, K_{i+1})$

z_{i+1} from equation (4)

Letting superscript $j = 1,2,3, \ldots\ldots$ represents the number trials (loop A above), the sequence is terminated when

$$(z_{i+1})^j - (z_{i+1})^{j-1} \leq 1(10^{-4})$$

In this program M is the overall control. For example, if M is preset to a value less than N the solution will terminate before the valve is full open (i.e., $M < N$); filling time and overtravel will not be evaluated.

c. <u>Numerical Integration (Predictor-Corrector)</u>. Equations (2a) and (2b) are considered in the form

$$V_{i+1}^2 = \pm \frac{2g}{K_{i+1}} \left[\varepsilon (Z_{ref} - z_{i+1}) - \frac{L}{g} \frac{dv}{dt_{i+1}} \right] \qquad (3)$$

Equation (2), using a first-order difference, is approximated by

$$z_{i+1} = z_i + \varepsilon \frac{V_{i+1} + V_i}{2} A_r \Delta t \qquad (4)$$

The predictor is based on the backwards difference

$$\frac{dV}{dt_{i+1}} \approx \frac{V_{i+1} - V_i}{\Delta t} \qquad (5)$$

Whereas the corrector uses the centered difference

$$\frac{dV}{dt_{i+1}} \approx \frac{V_{i+2} - V_i}{2\Delta t} \qquad (6)$$

Substituting (4) and (5) in (3), and (4) and (6) in (3), yields the predictor, $F_p(z,V,K)$ and the corrector functions $F_c(z,V,K)$, respectively. The algebraic relationships are shown in Table 1; the sequence of calculations at each time step is as follows.

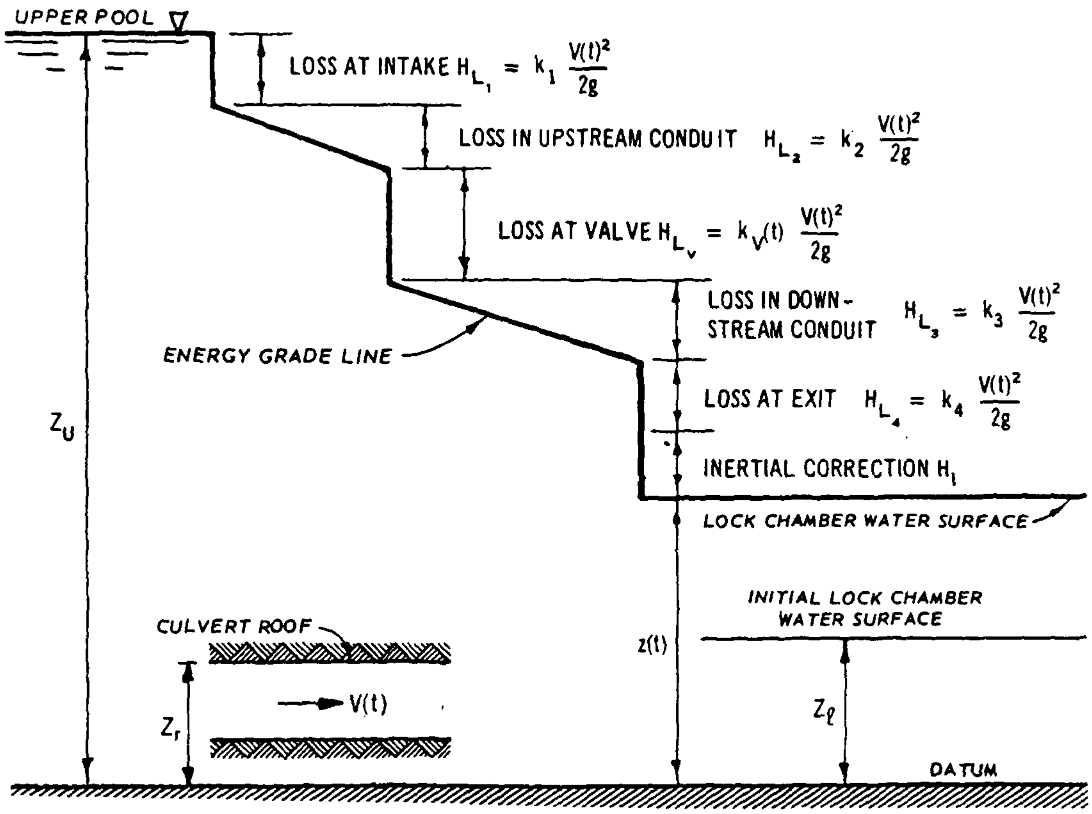


Figure 1. Simulated flow conditions at time t (filling operation)

Table 1. Parameters Used in Setting Up the Basic Model

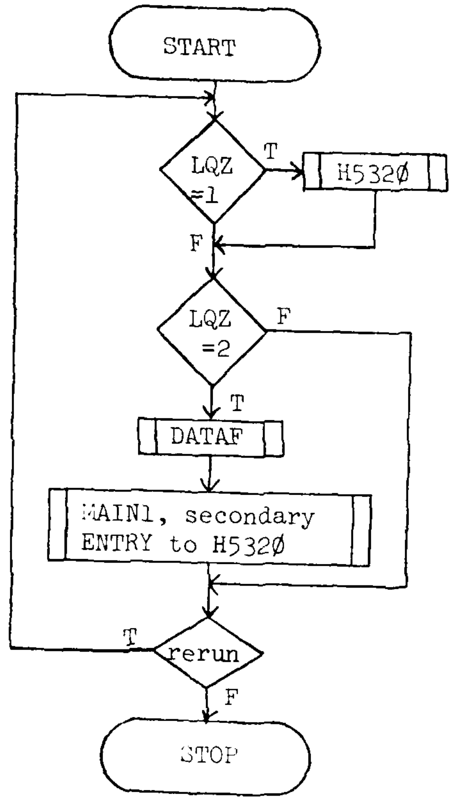
Item (Refer to Figure 1)	Type of Operation	Description
1. Fixed pool elevation, Z_{ref}	Filling	Z_u upper pool elevation
	Emptying	Z_L, lower pool elevation
2. Variable water-surface elevation (z)	Both	lock chamber water-surface elevation
3. Reference area, A	Both	$A = n_c A_c$, where A_c is the cross-sectional area of the culvert immediately below the valve, and n_c equals 1 or 2 for single or double valve operation, respectively.
4. Flowrate, Q	Filling	Total inflow (outflow is negative)
	Emptying	Total outflow (inflow is negative)
5. Reference velocity, V	Both	$V = Q/A$
6. Intake loss, $H_{\ell 1} = \frac{K_1 V\|V\|}{2g}$	Filling	Headloss at the culvert intake; K_1 is constant
	Emptying	Headloss between the chamber and the culverts; K_1 is constant
7. First conduit loss, $H_{\ell 2} = \frac{K_2 V\|V\|}{2g}$	Both	Loss in the culvert upstream from the valve; K_2 is constant
8. Valve loss, $H_{\ell v} = \frac{K_v V\|V\|}{2g}$	Both	Loss at the valve (K_v is a function of the valve opening ratio until full open; $K_v = 0.10$ thereafter)
9. Second conduit loss, $H_{\ell 3} = \frac{K_3 V\|V\|}{2g}$	Both	Loss in the culvert downstream from the valve; K_3 is constant

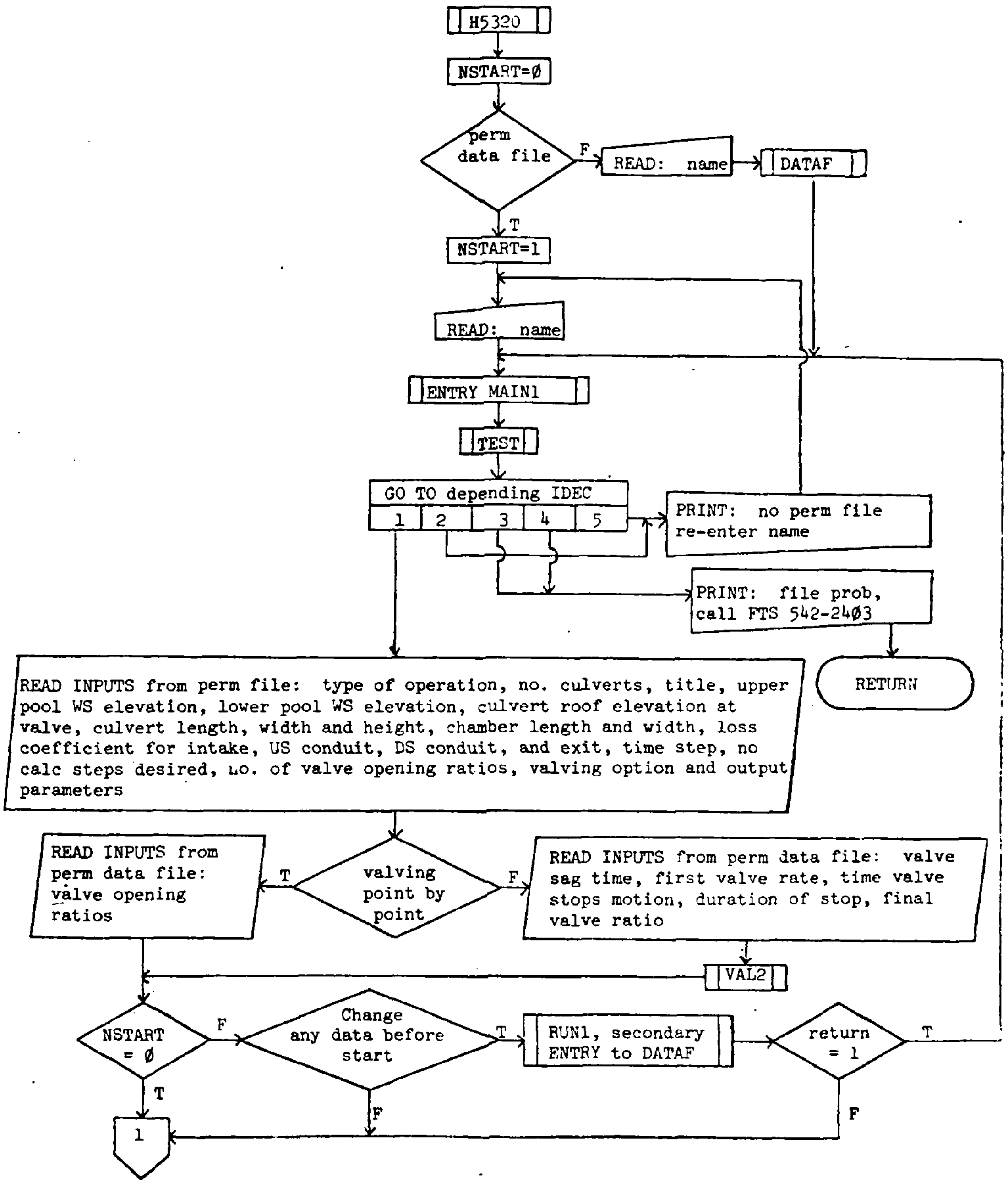
Item (Refer to Figure 1)	Type of Operation	Description
10. Exit loss, $H_{\ell 4} = \frac{K_4 V\|V\|}{2g}$	Filling	Loss at the ports into the lock chamber, K_4 is constant
	Emptying	Loss at the downstream exit from the culvert; K_4 is constant
11. Inertia "head" $H_e = \frac{L}{g}\frac{dV}{dt}$	Both	The inertia "head" is placed at the downstream end of the culvert (i.e., along with $H_{\ell 4}$); L is an effective culvert length, g is the acceleration of gravity, and dv/dt is the rate-of-change of velocity, V, with respect to time, t.

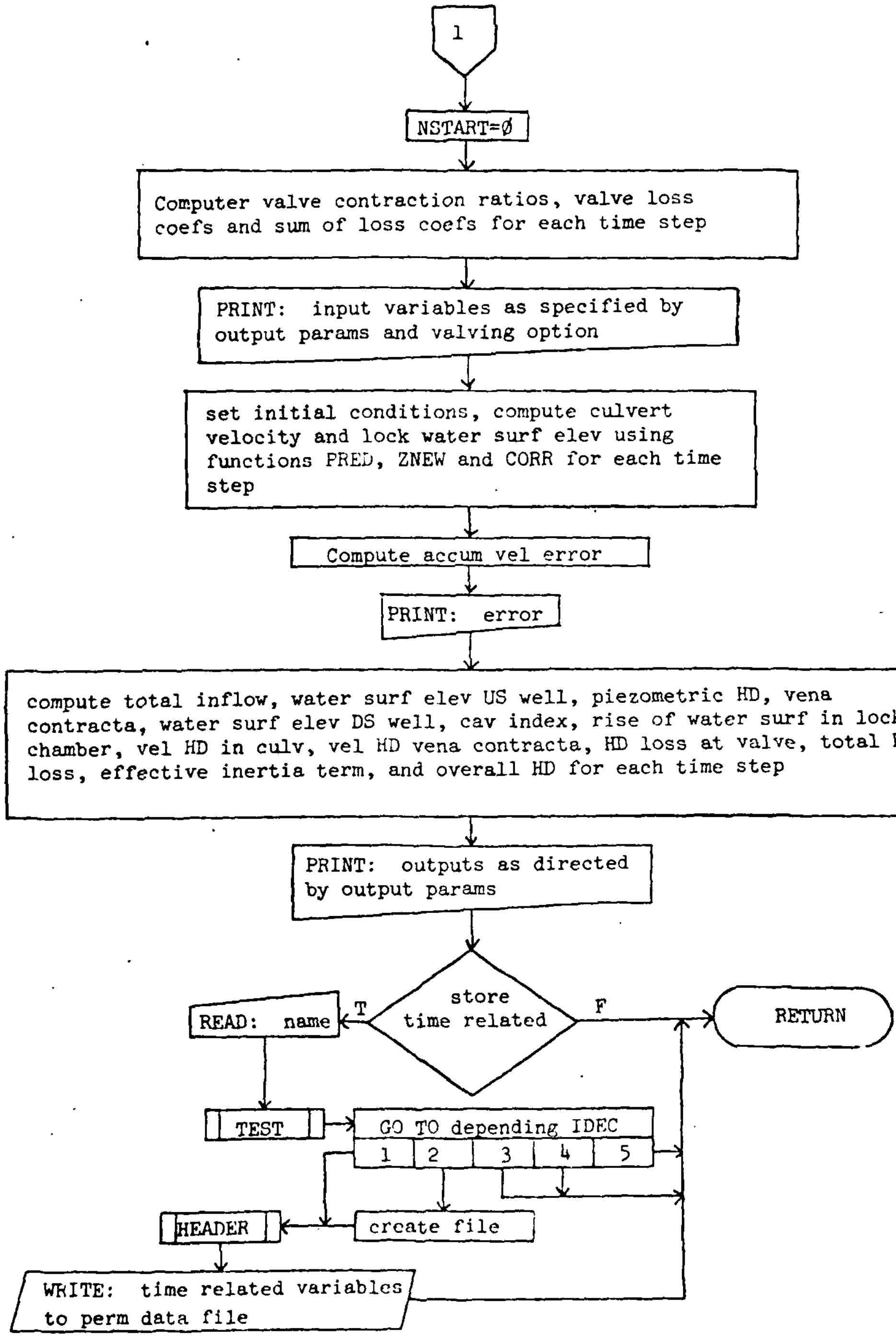
PART II: COMPUTER FUNCTIONAL DESCRIPTION

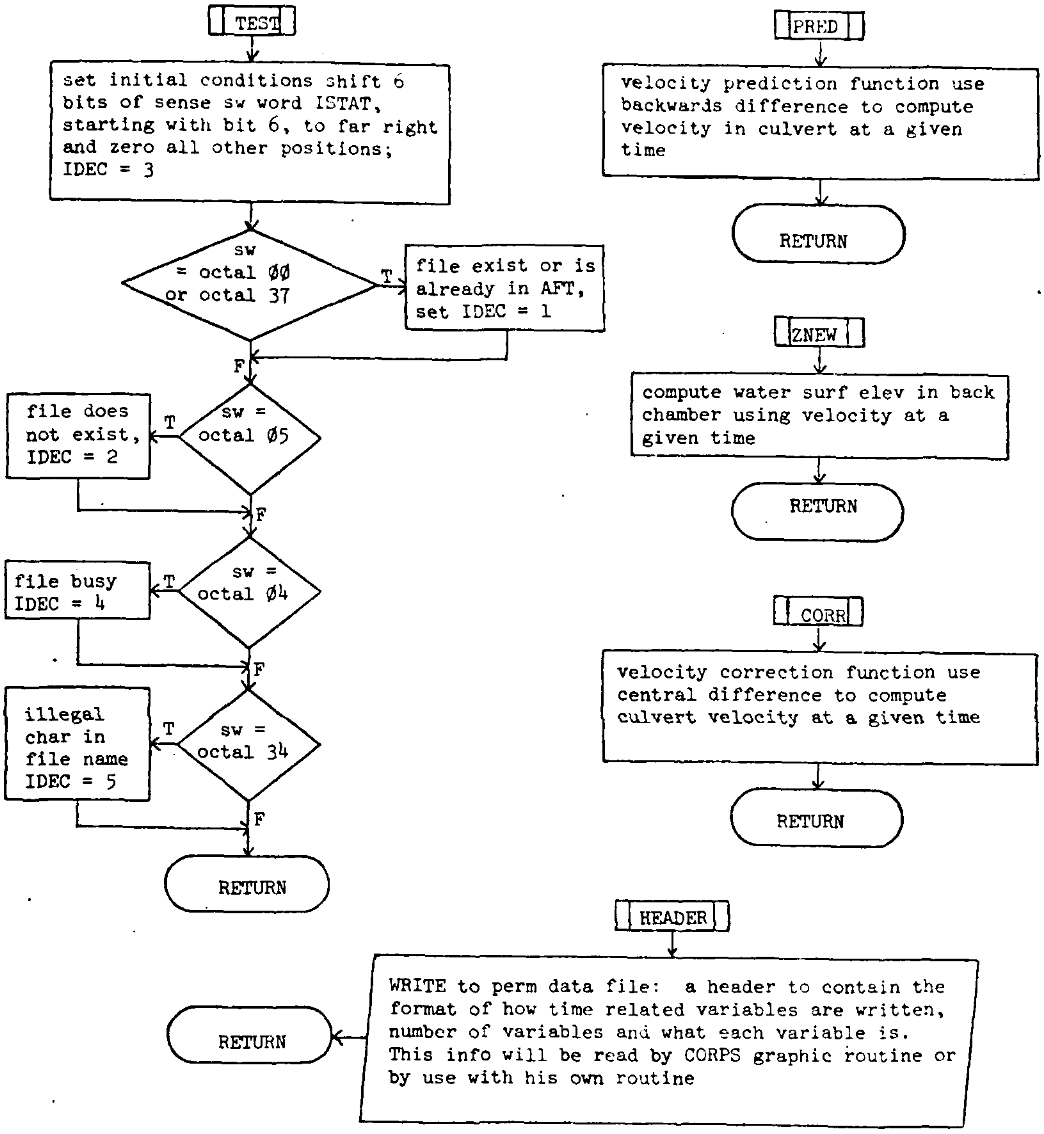
1. REVISION LOG: N/A

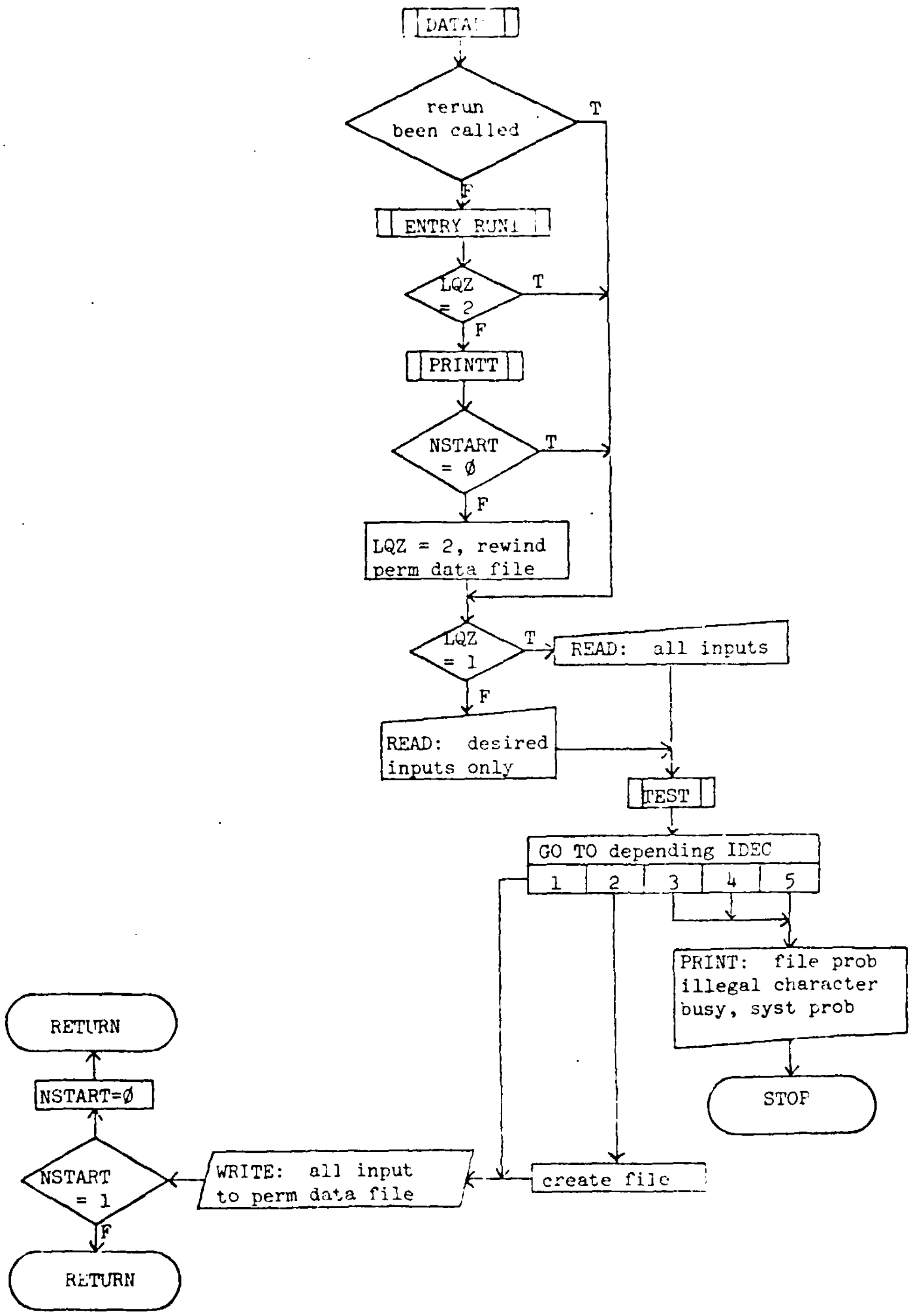
2. FUNCTIONAL FLOW CHART:

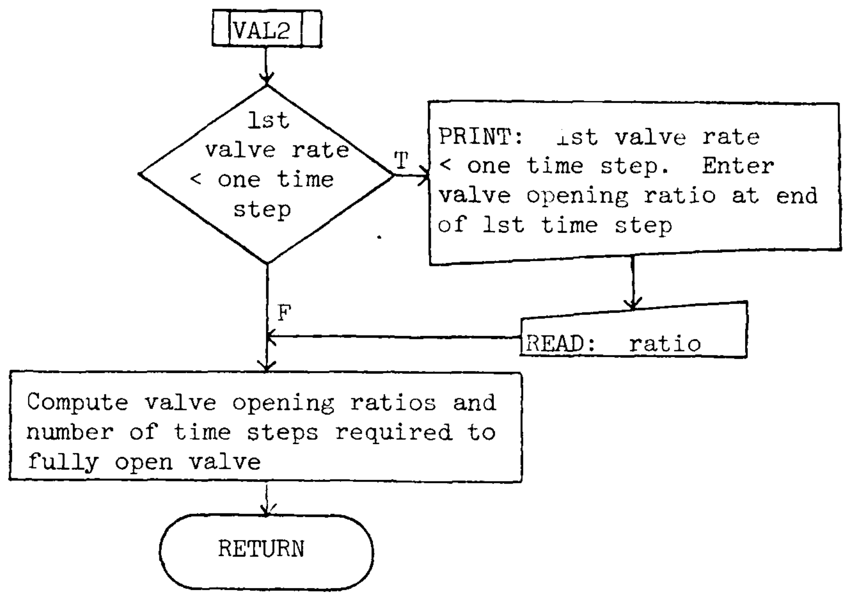


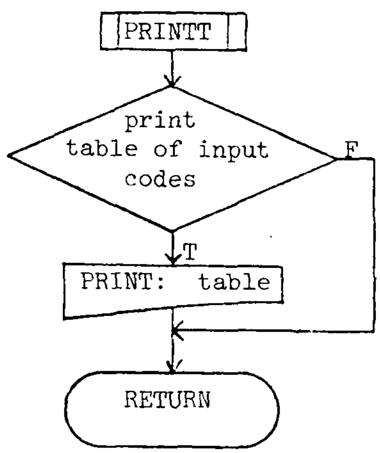

H5320
NSTART=Ø
perm data file
F
READ: name
DATAF
T
NSTART=1
READ: name
ENTRY MAIN1
TEST
GO TO depending IDEC
1 2 3 4 5
PRINT: no perm file re-enter name
PRINT: file prob, call FTS 542-24Ø3
RETURN
READ INPUTS from perm file: type of operation, no. culverts, title, upper pool WS elevation, lower pool WS elevation, culvert roof elevation at valve, culvert length, width and height, chamber length and width, loss coefficient for intake, US conduit, DS conduit, and exit, time step, no calc steps desired, no. of valve opening ratios, valving option and output parameters
READ INPUTS from perm data file: valve opening ratios
T
valving point by point
F
READ INPUTS from perm data file: valve sag time, first valve rate, time valve stops motion, duration of stop, final valve ratio
VAL2
NSTART = Ø
F
Change any data before start
T
RUN1, secondary ENTRY to DATAF
return = 1
T
T
F
F
1


1
NSTART=Ø
Computer valve contraction ratios, valve loss coefs and sum of loss coefs for each time step
PRINT: input variables as specified by output params and valving option
set initial conditions, compute culvert velocity and lock water surf elev using functions PRED, ZNEW and CORR for each time step
Compute accum vel error
PRINT: error
compute total inflow, water surf elev US well, piezometric HD, vena contracta, water surf elev DS well, cav index, rise of water surf in lock chamber, vel HD in culv, vel HD vena contracta, HD loss at valve, total HD loss, effective inertia term, and overall HD for each time step
PRINT: outputs as directed by output params
store time related
T
F
RETURN
READ: name
TEST
GO TO depending IDEC
1
2
3
4
5
HEADER
create file
WRITE: time related variables to perm data file


TEST
set initial conditions shift 6 bits of sense sw word ISTAT, starting with bit 6, to far right and zero all other positions; IDEC = 3
sw = octal ØØ or octal 37
T
file exist or is already in AFT, set IDEC = 1
F
sw = octal Ø5
T
file does not exist, IDEC = 2
F
sw = octal Ø4
T
file busy IDEC = 4
F
sw = octal 34
T
illegal char in file name IDEC = 5
F
RETURN
PRED
velocity prediction function use backwards difference to compute velocity in culvert at a given time
RETURN
ZNEW
compute water surf elev in back chamber using velocity at a given time
RETURN
CORR
velocity correction function use central difference to compute culvert velocity at a given time
RETURN
HEADER
WRITE to perm data file: a header to contain the format of how time related variables are written, number of variables and what each variable is. This info will be read by CORPS graphic routine or by use with his own routine
RETURN


DATA
rerun been called
T
F
ENTRY RUN1
LQZ = 2
T
F
PRINTT
NSTART = Ø
T
F
LQZ = 2, rewind perm data file
LQZ = 1
T
READ: all inputs
F
READ: desired inputs only
TEST
GO TO depending IDEC
1
2
3
4
5
PRINT: file prob illegal character busy, syst prob
STOP
create file
WRITE: all input to perm data file
NSTART = 1
F
NSTART=Ø
RETURN
RETURN


VAL2
1st valve rate < one time step
T
F
PRINT: 1st valve rate < one time step. Enter valve opening ratio at end of 1st time step
READ: ratio
Compute valve opening ratios and number of time steps required to fully open valve
RETURN


PRINTT
print table of input codes
F
T
PRINT: table
RETURN

3. EQUIPMENT AND OPERATING SYSTEM: The program was developed on a G635 time-share system in which input/output equipment consisted of a Model 33 remote teletype. It is now operational on the WES G635, Vicksburg, MS; HIS 66/8Ø, Macon, GA; and Boeing CDC, Seattle, WA.

4. INPUT REQUIREMENTS: The required inputs are entered via the user's time-share terminal device in free field format or are read from a permanent input data file. If the inputs are entered through a terminal device, then the input subroutine DATAF will supply all necessary cues and reads for the input data. A user named permanent file will be created by DATAF and the inputs written to it. All the inputs from DATAF are passed to the computation subroutine H532Ø via the COMMON statement. If the inputs are entered from an existing data file, then the inputs are read directly by H532Ø. H532Ø also handles all the required output.

5. SECONDARY STORAGE INPUT FORMAT:

a. The following formats are used for the input data file whether it already existed or was created by a run of program H532Ø.

To write:

```
56 FORMAT(I3,2F4.Ø,A35/I3,3F8.3/I3,5F8.3/I3,4F8.3/I3,F5.1,2I4,5I2)
57 FORMAT(I3,1ØF6.3)
```

To read:

```
1Ø1ØØ FORMAT(3X,2F4.Ø,A35)
1ØØ9Ø FORMAT(3X,3F8.3/3X,5F8.3/3X,4F8.3/3X,F5.1,2I4,5I2)
1Ø11Ø FORMAT(3X,1ØF6.3)
```

Refer to line numbers 24160-24180 and 24200 or 24220 for variable matchup of the above write formats. Refer to 20690-20710 and 20740 or 20760 for read formats. These line numbers are in the source listings on pages 50, 43, and 44. An example data file is:

```
100  1.   2.EXAMPLE 2
102 262.800 169.500 128.000
104 390.000  12.000  14.000 685.400  86.000
106   0.200   0.060   0.180   0.850
108 10.0   31   17 2 1 0 1 3
110 0.120 1.000 0.500 2.000 3.000
```

b. If the user decides to save the time-related output for graphics or other use, then an existing user data file or a newly created user named file is written to in the following manner.

(1) Subroutine HEADER writes all of its header information to the file. This header information is used by the CORPS system for graphics use. If the user wishes to read only the time-related output from the data file, use the format as described in the second line of header information. Refer to line numbers 24900-25020 of the source listing on page 52 for a complete description of header formats.

(2) The time-related variables are written by the following format.

```
10430 FORMAT(I3,3F6.2,F8.3,F9.0,4F8.3/F9.2,2F6.2,F8.2,5F8.2)
```

Refer to line numbers 22100-22120 in the source listing on page 46 for variable matchup to the format. An example file is:

```
H5320 13 15 EDGE
(15(/),(3X,3F6.2,F8.3,F9.0,4F8.3/F9.2,2F6.2,F8.2,5F8.2))
 31  31  31  31  31  31  31  31  31  31  31  31  31  31  31  31  31 31
 1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1
C"P"E DESIGNATIONS FOP H5320 APE:
 1=TIME                             10=CAVITATION PAPAMETEP
 2=VAL"E OPENING PATIO              11=PATE-OF-PISE
 3=CONTPACTION COEF.                12=VELOCITY AT PEF APEA
 4=LOG(VAL"E LOSS COEF.)            13=VELOCITY HD AT PEF APEA
 5=TOTAL INFLOW                     14=VELOCITY HD AT "ENA CONT
 6=LOCK WATEP S"PFACE(W-S)          15=HEADLOSS THP" VALVE
 7="/S VAL"E WELL W-S               16=TOTAL HEADLOSS
 8=PIEZ HD BELOW VALVE              17=INEPTIAL TEPM
 9=D/S VAL"E WELL W-S               18=W-S DIFFEPENTIAL
"NITS FOP ABOVE VAPIABLES APE:
 MIN"TES=1          FT/MIN=11
 NONE=2,3,4,10      FT/SEC=12
 CFS=5              FT=13,14,15,16,17,18
 FT-DAT"M=6,7,8,9
```

100	0.	0.	0.30	4.00	0.	169.500	262.800	169.500	169.500
	9.99	0.	0.	0.	0.	93.30	93.30	0.	93.30
102	0.17	0.11	0.73	2.11	2190.	169.656	261.969	166.663	170.246
	0.88	2.23	6.52	0.66	95.97	84.19	85.04	8.03	93.11
104	0.33	0.23	0.70	1.47	4453.	170.249	259.363	157.576	172.566
	0.71	4.53	13.25	2.73	104.51	79.74	83.26	9.66	92.55
106	0.50	0.38	0.65	0.98	7548.	171.267	252.926	133.883	177.929
	0.39	7.63	22.47	7.84	126.88	75.53	85.64	5.92	91.53
108	0.67	0.33	0.65	0.98	7737.	172.564	252.427	127.374	179.561
	0.32	7.83	23.03	3.23	133.29	79.35	89.97	0.27	90.24
110	0.83	0.38	0.65	0.98	7699.	173.373	252.523	128.688	182.803
	0.33	7.84	22.91	8.15	131.99	78.53	89.09	-0.17	88.93
112	1.00	0.38	0.65	0.98	7644.	175.175	252.674	130.596	182.826
	0.35	7.78	22.75	8.04	130.11	77.46	87.33	-0.20	87.63
114	1.17	0.33	0.65	0.93	7583.	176.467	252.823	132.537	183.197
	0.37	7.72	22.53	7.92	123.20	76.32	86.54	-0.20	86.33
116	1.33	0.38	0.65	0.93	7531.	177.749	252.970	134.467	184.350
	0.40	7.67	22.41	7.80	126.30	75.19	85.25	-0.20	85.05
118	1.50	0.38	0.65	0.93	7475.	179.022	253.117	136.333	185.554
	0.42	7.61	22.25	7.63	124.42	74.07	83.98	-0.20	83.73
120	1.67	0.33	0.65	0.93	7418.	180.285	253.263	138.285	186.719
	0.44	7.55	22.03	7.57	122.55	72.95	82.72	-0.20	82.51
122	1.83	0.38	0.65	0.98	7362.	181.539	253.407	140.172	187.875
	0.46	7.49	21.91	7.45	120.69	71.85	81.46	-0.20	81.26
124	2.00	0.33	0.65	0.98	7305.	182.783	253.551	142.045	189.023
	0.47	7.44	21.74	7.34	118.85	70.75	80.22	-0.20	80.02
126	2.17	0.38	0.65	0.98	7249.	184.018	253.693	143.904	190.161
	0.51	7.33	21.57	7.23	117.02	69.66	78.99	-0.20	78.78
128	2.33	0.33	0.65	0.98	7193.	185.243	253.834	145.748	191.291
	0.53	7.32	21.41	7.12	115.20	68.58	77.76	-0.33	77.56
130	2.50	0.38	0.65	0.98	7040.	186.450	254.212	150.674	192.244
	0.60	7.17	20.95	6.32	110.35	65.69	74.49	1.82	76.35
132	2.67	0.44	0.66	0.30	8200.	187.743	251.147	150.011	195.624
	0.59	8.35	24.48	9.25	110.38	58.40	70.33	4.69	75.00
134	2.83	0.52	0.67	0.61	9645.	189.256	246.682	146.194	202.131
	0.53	9.39	28.72	12.79	113.28	51.56	68.00	5.43	73.54
136	3.00	0.56	0.69	0.40	11241.	191.028	240.963	143.752	205.640
	0.50	11.44	33.45	17.38	114.53	43.57	65.99	5.62	71.77
138	3.17	0.63	0.72	0.18	12873.	193.074	234.051	144.831	212.447
	0.51	13.10	38.31	22.79	112.04	34.74	64.14	5.67	69.73
140	3.33	0.70	0.74	-0.04	14303.	195.336	226.926	150.785	219.537
	0.60	14.65	42.88	28.47	104.66	25.84	62.57	4.97	67.41
142	3.50	0.77	0.78	-0.27	15629.	197.938	220.467	161.310	226.490
	0.77	15.91	46.52	33.66	92.75	17.65	61.19	3.81	64.87
144	3.67	0.85	0.82	-0.51	16501.	200.655	215.613	174.877	232.450
	1.05	16.80	49.11	37.45	78.19	11.49	59.80	2.46	62.14
146	3.83	0.92	0.86	-0.76	16992.	203.499	212.768	188.141	237.854
	[illegible]	17.38	52.57	39.71	63.33	6.97	58.20	1.26	59.32
148	4.00	1.00	0.90	-1.00	17201.	206.399	211.500	201.976	240.[illegible]
	2.16	17.51	51.19	40.70	50.74	4.07	56.57	-0.13	56.42
150	4.17	1.00	0.90	-1.00	16922.	209.294	213.175	208.937	242.771
	2.27	17.22	50.36	39.33	45.62	3.94	54.73	-1.23	53.51
152	4.33	1.00	0.90	-1.00	16520.	212.130	215.504	210.699	244.037
	2.44	16.82	49.17	37.54	46.34	3.75	52.13	-1.53	52.67
154	4.50	1.00	0.90	-1.00	16037.	214.696	217.949	209.599	245.153
	2.64	16.33	47.83	35.60	43.95	3.56	49.43	-1.57	47.90
156	4.67	1.00	0.90	-1.00	15647.	217.588	220.373	212.474	246.212
	2.86	15.93	46.57	33.67	41.57	3.37	46.86	-1.59	45.31
158	4.83	1.00	0.90	-1.00	15204.	220.285	222.740	215.033	247.019
	3.10	15.48	45.25	31.79	39.25	3.13	44.19	-1.62	42.59
160	5.00	1.00	0.90	-1.00	14760.	222.747	225.042	213.014	245.213
	3.36	15.02	43.95	29.97	36.99	3.00	41.65	-1.60	40.05

6. INPUT DATA DESCRIPTION: The following names are used for the input variables in program H532∅.

AAB - 8 char name of perm data file

DTS - time step, sec

IDEL1 - output control to valve full open; = 1, print every time step value; = 2, print every 2nd value; = n, print every nth value

IDEL2 - output control from valve full open to complete solution; = 1, print every time step value; = 2, print every 2nd value; = n, print every nth value

IPRIN1 - output control for engineering values; = 1, print: conduit and chamber geometry, loss coefs and elevs; = ∅, no print

IPRIN2 - output control for head loss distributions; = 1, print; = ∅, no print

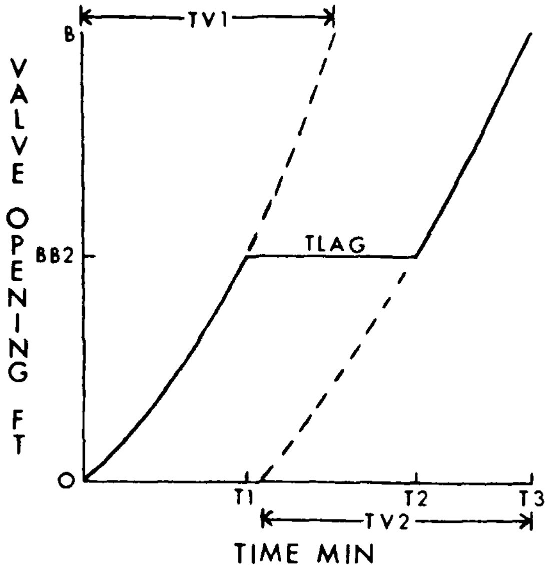
IVALV - type of valving; = 1, point by point; = 2, programmed functions

M - number of calculated steps desired

N - number of values of valve opening ratios (point by point)

RUN - 35 char problem name

SAG - sag at one-half valve time of the nondimensional valve opening pattern (programmed function)



TV1	-	first valve rate (programmed function), time taken for valve from closed to full open position with no stop, min to full open
T1	-	time valve stops initial motion (programmed function), min; no stop, T1 = TV1
TLAG	-	duration of stop (programmed function), min; no stop, TLAG = Ø
TV2	-	second valve rate (programmed function), time taken for valve from closed to full open position as if no stop, min to full open. If actually no stop, TV2 = TV1, never Ø.
TYPE	-	type of operation; = 1, filling; = 2, emptying; = Ø stop program
XBB	-	valve opening ratios (point by point)
XK1	-	intake loss coef
XK2	-	upstream conduit loss coef

XK3 - downstream conduit loss coef

XK4 - exit loss coef

XL1 - culvert length, ft

XL2 - culvert width, ft

XL3 - culvert height, ft

XL4 - chamber length, ft

XL5 - chamber width, ft

XN - number of culverts

ZL - lower pool elev, ft-datum

ZR - culvert roof elev at valve, ft-datum

ZU - upper pool elev, ft-datum

7. <u>OUTPUT DATA DESCRIPTION</u>: All output is generated within subroutine H532Ø. It includes the given input data, plus the output data as described in the following variables.

BB2 - valve opening at end of first valve motion (programmed function), ft; Refer to figure given in (6) INPUT DATA DESCRIPTION

CI - cavitation index

ERROR - accumulated velocity error, ft^2/sec^2

H - overall head, ft

HI - effective inertia, ft

HLT - total head loss, ft

HLV - head loss at valve, ft

I - count of the number of time steps at which accumulated velocity error is printed

M1 - number of steps to fill or empty lock chamber, if input M (number of calculated steps desired) is sufficiently large to complete solution

M2 - number of steps to peak overfill or under empty, if input M is sufficiently large to complete solution

NC - number of culverts

Q - total inflow, cfs

RR - rise of water level in lock chamber, ft/min

T3 - valve opening time, min

V - velocity in culvert, fps

VH - velocity head in culvert, ft

VHVC - velocity head at vena contracta, ft

XBB - valve opening ratio

XCC - valve contraction ratio

XKC - equivalent lock coef (based on loss coefs)

XKT - sum of loss coefs (including valve) at valve full open

XKV - valve loss coef

XT - time at each calculation, min

XTM - time at extreme elev, min

XTX - time to complete operation, min

Z - lock chamber water surface elev, ft-datum

ZOW - water surface elev in downstream well, ft-datum

ZOT - Lock chamber overfill or empty, ft

ZUW - water surface elev in upstream well, ft-datum

ZV - piezometric head elev at vena contracta, ft-datum

8. PROGRAM ERROR MESSAGES:

a. If file name INDATA is entered as the name of your permanent data file and INDATA does not exist, then

NO FILE INDATA. ENTER FILE NAME OR STOP.

is printed from subroutine H5320. This is repeated until an existing file is attached or the reply STOP is entered. If STOP is entered, then control is returned to the main program. Since program only checks file to see if it exists, "be sure" file is your input data file. If not your data file, program will attempt to read bad data and/or abort.

b. If a program or system error occurs in an attempt to attach your data file, then

FILE PROBLEM. CALL FTS 542-2403 AND GIVE THIS NUMBER ISTAT
(where ISTAT is a 12 digit octal number)

is printed from subroutine H5320. Control is then returned to the main program.

c. If program cannot create or attach an output file for your request of an output data file, then

FILE PROBLEM;ILLEGAL CHAR;BUSY;OR SYSTEM PROBLEM
OUTPUT VALUES NOT SAVED AS REQUESTED

is printed from subroutine H5320. Control is returned to the main program.

d. If first valve rate is less than one time step, then

    YOUR 1ST VALVE RATE IS < ONE TIME STEP
    ENTER VALVE OPENING RATIO AT END OF 1ST TIME STEP

is printed from subroutine VAL2. The ratio is read and program continues to next statement.

e. If program cannot create or attach your input data file, then

    FILE PROBLEMS;ILLEGAL CHAR;BUSY;OR SYSTEM PROB.

is printed from subroutine DATAF. Control is returned to the main program.

9. VARIABLE DEFINITIONS:

a. Main program

HFILE - 5 char, name of program; passed to WESLIB, count routine HACCT

LQZ - equal 1, execute all input cues and reads; equal 2, call WESLIB routine RERUN and enter only desired inputs; initialized to 1 in main program for first run, 2 thereafter

LQX - equal 1, print instructions for RERUN; equal 3 no print; initialized to 1 in main program

ZZZZZ - 2 char; equal RE, rerun; equal ST, stop

b. Subroutine H5320, main computation routine

AAA - 1 char; equal to Y for yes and N for no for response to yes or no question

AAB - 8 char, name of permanent data file

AAC - 1Ø char, used for attaching permanent data file

AAD - 8 char, name of output file for graphics and/or other use

AAE - 1Ø char, used for attaching output file for graphics and/or other use

AR - ratio of total culvert(s) cross-section area to lock chamber water surface area

B - constant = 2.2, used to determine valve loss coef

BB1 - valve opening ratio at end of first valve motion (programmed function)

BB2 - valve opening at end of first valve motion (programmed function) ft

C - constant = 3.2, used to determine valve loss coef

CFILE - 25 char, used for creating output file for graphics and/or other use

CI - cavitation index

CORR - velocity correction FUNCTION subprogram (central difference), fps

D - constant = .65, used to determine valve contraction coef

DTM - time step, min

DTS - time step, sec

E - constant = .9, used to determine valve contraction coef

ERROR - accumulated velocity error, ft^2/sec^2

F - constant = .9, used to determine valve contraction coef

H - overall head, ft

HI - effective inertia term, ft

HLT - total head loss, ft

HLV - head loss at valve, ft

HL1 - intake head loss, ft

HL2 - upstream conduit head loss, ft

HL3 - downstream conduit head loss, ft

HL4 - exit head loss, ft

I - count of the number of time steps

IDEC - switch equal to:

1 - file exist or is in AFT
2 - file nonexistent
3 - file problem
4 - file busy
5 - illegal char in file name

IDEL1 - output control to valve full open; = 1, print every time step value; = 2, print every 2nd value; = n, print every nth value

IDEL2 - output control from full open to completed solution; = 1, print every time step value; = 2, print every 2nd value; = n, print every nth value

IPRIN1 - output control for engineering input variables; = 1, print; = Ø, no print

IPRIN2 - output control for loss distribution; = 1, print; = Ø, no print

IVALV - type of valving; = 1, point by point; = 2, programmed function

IVAL1 - switch variable set to Ø to be passed to subroutine DATAF

IVAL2 - switch variable set to Ø to be passed to subroutine DATAF

KK - switch variable set to Ø to be passed to subroutine DATAF

LINE - line numbers in output file for graphics and/or other use

M - total number of calculated steps desired

M1 - number of steps to fill or empty lock chamber if M is sufficiently large to complete solution

M2 - number of steps to peak overfill or under empty if M is sufficiently large to complete solution

M3 - switch; omit corrector sequence for low velocity flows

N - number of valve opening ratios

NC - number of culverts

NSTART - switch; = 1 if input is first read from permanent data file, else = Ø

PRED - velocity prediction FUNCTION subprogram (backward difference), fps

Q - total inflow, cfs

RR - rise of water in lock chamber, fpm

RUN - 35 char problem name

SAG - sag at one-half valve time of the nondimensional valve opening pattern (programmed function)

T1 - time valve stops initial motion (programmed function), min

TLAG - duration of stop (programmed function), min

T3 - valve opening time, min

TV1 - first valve rate (programmed function), time taken for valve from closed to full open with no stop, min to full open

TV2 - second valve rate (programmed function), time taken for valve from closed to full open as if no stop, min to full open. If actually no stop, TV2 = TV1, never Ø

TYPE - type of operation; = 1, fill; = -1, empty; = Ø, stop program

V - velocity in culvert, fps

VH - velocity head in culvert, ft

VHVC - velocity head at vena contracta, ft

XBB - valve opening ratios

XCC - valve contraction ratios

XK - sum of loss coefs (including valve)

XKC - equivalent lock coef (based on loss coefs)

XKT - sum of loss coefs (including valve) at valve full open

XKV - valve loss coef

XK1 - intake loss coef

XK2 - upstream loss coef

XK3 - downstream loss coef

XK4 - exist loss coef

XL1 - culvert length, ft

XL2 - culvert width, ft

XL3 - culvert height, ft

XL4 - chamber length, ft

XL5 - chamber width, ft

XN - number of culverts

XT - time at each calculation, min

XTM - time at extreme elev, min

XTX - time to complete operation, min

YY - working storage

Z - lock chamber water surface elev, ft-datum

ZCHEC - lock chamber water surface elev at time t_{i+1} , ft-datum

ZOW - water surface elev in downstream well, ft-datum

ZNEW - lock chamber water surface FUNCTION subprogram to evaluate successive elevs, ft-datum

ZL - lower pool water surface elev, ft-datum

ZOT - lock chamber overfill or under empty, ft

ZR - culvert roof elev at valve, ft-datum

ZREF - upper pool water surface elev, filling; lower pool water surface elev, emptying; ft-datum

ZU - upper pool water surface elev, ft-datum

ZUW - water surface elev in upstream well, ft-datum

ZV - piezometric head elev at vena contracta, ft-datum

c. Function PRED, velocity prediction function; uses backwards difference to evaluate the culvert velocity at a given time.

AR - ratio of total culvert(s) cross-section area to lock chamber water surface area

DTS - time step, sec

PRED - symbolic name of single valued function used as the return for the output value to the calling program, fps

TYPE - type of operation; = 1, filling; = -1, emptying

VST - culvert velocity at time t_i or t_{i+1} , fps

XB - working storage

XC - working storage

XKF - sum of loss coefs (including valve) at time t_{i+1} or t_{i+2}

XL1 - culvert length, ft

ZREF - upper pool water surf elev, filling; lower pool water surface elev, emptying; ft-datum

ZST - lock chamber water surface elev at time t_i or t_{i+1} , ft-datum

d. Function COOR, velocity correction function; uses central difference to evaluate the culvert, velocity at a given time.

AR - ratio of total culvert(s) cross-section area to lock chamber water surface area

CORR - symbolic name of single valued function used as the return for the output value to the calling program, fps

DTS - time step, sec

TYPE - type of operation; = 1, filling; = -1, emptying

VAH - culvert velocity at time t_{i+1} or t_{i+2} , fps

VST - culvert velocity at time t_{i-1} or t_i , fps

XB - working storage

XC - working storage

XKF - sum of loss coefs (including valve) at t_{i-1} or t_i

XL1 - culvert length, ft

ZREF - upper pool water surface elev, filling; lower pool water surface elev, emptying; ft-datum

ZST - lock chamber water surface elev at time t_{i-1} or t_i , ft-datum

e. Function ZNEW, evaluate water surface elev in lock chamber using velocity at a given time.

AR - ratio of total culvert(s) cross-section area to lock chamber water surface area

DTS - time step, sec

TYPE - type of operation; = 1, filling; = -1, emptying

VF - culvert velocity at time t_{i+1} , fps

VST - culvert velocity at time t_i , fps

ZNEW - symbolic name of single valued function used as the return for the output value to the calling program, ft-datum

ZST - lock chamber water surface elev at time t_i , fps

f. Subroutine TEST, determine status codes returned by file system for an attach operation.

IDEC - decimal value for status codes; IDEC =
1 - file exist or is in AFT
2 - file nonexistent
3 - file problem
4 - file busy
5 - illegal char in file name

ISTAT - status code (12 digit octal number) returned by file system; converted to decimal as represented by IDEC

ITEST - 2 digit octal number = ØØ, Ø4, Ø5, 34 or 37; used as test against status code ISTAT to determine IDEC value

g. Subroutine VAL2, called if valve option is programmed functions. Computes valve opening ratios and number of time steps to fully open valve.

A - sag at one-half valve time of the nondimensional valve opening pattern

BB1 - valve opening ratio at end of 1st time step

DTM - time step, min

DTS - time step, sec

N - number of values of valve opening ratios

PI - constant = 3.141593

TLAG - duration of stop, min

TV1 - first valve rate, time taken for valve from closed to full open with no stop, min to full

TV2 - second valve rate, time taken for valve from closed to full open as if no stop, min to full. If actually no stop, TV2 = TV1, never = Ø

T1 - time valve stops initial motion, min

T2 - time at which valve motion starts following the partial-open stop, min

T2N - working storage

T2S - working storage

XBB - valve opening ratios

XT - time at each calculated ratio, min

h. Subroutine DATAF, supports inputs via teletype and rerun option.

All variables are as described in subroutine H5320 except:

CFILE - 24 char, used for creating a permanent input data file

LQZ - equal 1, execute all input cues and reads; equal 2, call WESLIB routine RERUN and enter only desired inputs

IVAL1 and IVAL2 - switch pair for setting value of rerun option LQZ

IVAL1 and	IVAL2	sets LQZ
1	Ø	2
Ø	1	2

all other conditions, switch ignored

KK - switch for rerun option LQZ; KK = 1 sets LQZ = 2; any other value of KK, switch ignored

KKK - total number of inputs, passed to RERUN

JKL - direct return from RERUN to desired input read

LQX - equal 1, print instructions from RERUN; equal 3, no print

i. Subroutine PRINTT, provides a listing of input variables at the teletype during a run of program H5320.

AAA - 1 char; = N, no print listing; = Y, print

j. Subroutine HEADER, called if desire output stored for graphics and/or other use. HEADER writes a heading to the output file which contains the format the file was written in, the number of time related variables written and what each variable is, and the type of axis to graph the data on. The time related variables are then written under the heading.

M - number of calculated steps

10. EXAMPLE CASE: Determine the hydraulic performance of a lock culvert system during a filling operation.

a. Input Data:

Type operation	1
Problem title	Example 1
No. culverts	2
Upper pool elev, ft-datum	262.8Ø
Lower pool elev, ft-datum	169.5Ø
Culvert roof elev, ft-datum	128.ØØ
Culvert length, ft	39Ø.ØØ
Culvert width, ft	12.ØØ
Culvert height, ft	14.ØØ
Chamber length, ft	685.4Ø

Chamber width, ft	86.ØØ
Intake loss coef	Ø.2Ø
U. S. loss coef	Ø.Ø6
D. S. loss coef	Ø.18
Exit loss coef	Ø.85
Time step, sec	1Ø.ØØ
No. of stepped values	73
Type of valving	2
Valve sag at 1/2 open time	Ø.12
First valve rate, min	4.ØØ
Time valve stops motion, min	4.ØØ
Duration of stop, min	Ø.ØØ
Final valve rate, min	4.ØØ
Output control, engr inputs	1
Output control, loss distribution	1
First output rate	1
Final output rate	3

b. <u>Output</u>:

```
EXAMPLE 1

CONDUIT GEOMETRY: LENGTH =   390.0 FT.   WIDTH= 12.0 FT.
                  HEIGHT= 14.0 FT.   N= 2-CULVERT OPERATION)

CHAMBER GEOMETRY: LENGTH = 685.4 FT.   WIDTH = 86.0 FT.

LOSS COEFFICIENT: INTAKE  0.200
         UPSTREAM CONDUIT 0.060
       DOWNSTREAM CONDUIT 0.180
                 MANIFOLD 0.850
        TOTAL(VALVE OPEN) 1.390   LOCK COEF.=0.848

ELEVATIONS: UPPER POOL 262.80
            LOWER POOL 169.50
          CULVERT ROOF 128.00


VALVE OPENS AT   4.00-MIN. RATE FOR   4.00 MINUTES


ACC.VEL. ERROR TO I= 58 IS   0.00595
ACC.VEL. ERROR TO I= 64 IS   0.00598


LOCK FILLS TO UPPER POOL IN  9.56 MINUTES
EXTREME ELEVATION AT TIME = 10.50 MINUTES
MAX COMPUTED OVERTRAVEL = 1.57 FT.
```

TIME (M)	OPEN. RATIO	CONT. COEF.	LOSS COEF.	TOTAL INFLOW CFS	LOCK CHAMBER	US VALVE WELL	PIEZ.HD VALVE	DS VALVE WELL	CAV.PAR.
VALVE PARAMETERS					ELEVATIONS (FT-DATUM)				
0.	0.00	0.80	10000.00	0.	169.50	262.80	169.50	169.50	9.99
0.17	0.03	0.80	2147.81	556.	169.55	262.75	164.34	169.53	0.84
0.33	0.05	0.79	531.46	1115.	169.69	262.58	163.62	169.83	0.83
0.50	0.08	0.79	232.25	1631.	169.93	262.31	162.38	170.26	0.80
0.67	0.11	0.78	127.64	2258.	170.26	261.92	160.56	170.86	0.77
0.83	0.14	0.76	79.36	2848.	170.69	261.39	158.07	171.64	0.72
1.00	0.17	0.75	53.25	3452.	171.23	260.74	154.80	172.62	0.67
1.17	0.20	0.73	37.63	4075.	171.87	259.92	150.37	173.81	0.60
1.33	0.23	0.70	29.23	4585.	172.60	259.16	151.25	175.06	0.61
1.50	0.26	0.68	22.63	5147.	173.43	258.21	148.24	176.52	0.57
1.67	0.30	0.65	17.28	5799.	174.35	256.97	140.57	178.29	0.47
1.83	0.34	0.65	13.00	6554.	175.40	255.36	140.19	180.42	0.46
2.00	0.38	0.65	9.64	7424.	176.59	253.25	138.10	183.03	0.44
2.17	0.42	0.66	7.04	8414.	177.93	250.53	134.95	186.21	0.40
2.33	0.47	0.67	5.06	9520.	179.45	247.09	131.48	190.05	0.36
2.50	0.51	0.68	3.59	10726.	181.17	242.86	128.59	194.62	0.33
2.67	0.56	0.69	2.51	11994.	183.10	237.87	127.25	199.92	0.31
2.83	0.61	0.71	1.73	13269.	185.24	232.29	128.43	205.82	0.32
3.00	0.67	0.73	1.18	14477.	187.59	226.48	132.81	212.10	0.37
3.17	0.72	0.75	0.80	15542.	190.14	220.94	140.53	218.38	0.46
3.33	0.77	0.78	0.53	16400.	192.85	216.19	151.06	224.29	0.60
3.50	0.83	0.81	0.35	17016.	195.68	212.62	163.36	229.54	0.82
3.67	0.89	0.84	0.23	17389.	198.60	210.40	176.21	233.95	1.12
3.83	0.94	0.87	0.15	17542.	201.57	209.47	188.57	237.54	1.52
4.00	1.00	0.90	0.10	17548.	204.54	209.43	199.50	240.54	2.03
4.50	1.00	0.90	0.10	16364.	213.19	216.39	207.75	244.50	2.51
5.00	1.00	0.90	0.10	15035.	221.18	223.62	216.33	247.61	3.20
5.50	1.00	0.90	0.10	13704.	228.49	230.25	224.19	250.45	4.10
6.00	1.00	0.90	0.10	12373.	235.13	236.27	231.33	253.03	5.30
6.50	1.00	0.90	0.10	11042.	241.09	241.67	237.74	255.34	6.96
7.00	1.00	0.90	0.10	9711.	246.37	246.46	243.41	257.40	9.36
7.50	1.00	0.90	0.10	8380.	250.97	250.63	248.36	259.18	9.99
8.00	1.00	0.90	0.10	7049.	254.90	254.19	252.59	260.71	9.99
8.50	1.00	0.90	0.10	5718.	258.15	257.13	256.08	261.97	9.99
9.00	1.00	0.90	0.10	4387.	260.72	259.47	258.84	262.97	9.99
9.50	1.00	0.90	0.10	3056.	262.61	261.18	260.88	263.71	9.99
10.00	1.00	0.90	0.10	1725.	263.83	262.28	262.19	264.18	9.99
10.50	1.00	0.90	0.10	394.	264.37	262.77	262.77	264.39	9.99
11.00	1.00	0.90	0.10	-833.	264.24	262.73	262.63	264.16	9.99
11.50	1.00	0.90	0.10	-1446.	263.64	262.59	262.30	263.39	9.99
12.00	1.00	0.90	0.10	-1393.	262.89	262.60	262.34	262.67	9.99

	PATE PISE (F/M)	VEL. (F/S)	VEL HDS(F) REF. APEA	VENA CONT.	DIFFEPENTIAL HDS(F) VALVE	TOTAL LOSS	INEPTIA	OVERALL
0.	0.	0.	0.	0.	93.300	93.300	0.	93.300
0.17	0.566	1.654	0.042	98.448	91.139	91.243	2.009	93.253
0.33	1.135	3.318	0.171	99.134	90.861	91.082	2.029	93.111
0.50	1.712	5.004	0.389	100.317	90.311	90.813	2.061	92.874
0.67	2.299	6.721	0.701	102.058	89.532	90.437	2.102	92.540
0.83	2.899	8.475	1.115	104.441	88.516	89.955	2.151	92.107
1.00	3.513	10.273	1.639	107.573	87.254	89.368	2.212	91.572
1.17	4.148	12.128	2.284	111.841	85.940	88.887	2.043	90.934
1.33	4.667	13.646	2.891	110.794	84.529	88.259	1.932	90.199
1.50	5.239	15.319	3.644	113.615	82.475	87.175	2.183	89.374
1.67	5.903	17.259	4.625	121.023	79.929	85.895	2.536	88.445
1.83	6.672	19.507	5.909	121.069	76.330	84.452	2.929	87.397
2.00	7.557	22.095	7.581	122.732	73.064	82.843	3.351	86.212
2.17	8.564	25.040	9.736	125.322	68.514	81.074	3.778	84.863
2.33	9.690	28.333	12.465	128.075	63.089	79.169	4.167	83.347
2.50	10.918	31.921	15.822	130.096	56.760	77.171	4.460	81.630
2.67	12.209	35.697	19.787	130.402	49.613	75.139	4.584	79.702
2.83	13.507	39.491	24.216	128.069	41.858	73.127	4.475	77.560
3.00	14.736	43.086	28.827	122.492	33.988	71.174	4.096	75.206
3.17	15.820	46.255	33.222	113.634	26.416	69.273	3.465	72.660
3.33	16.693	48.809	36.992	102.126	19.654	67.374	2.653	69.950
3.50	17.321	50.644	39.826	89.090	14.032	65.408	1.783	67.116
3.67	17.701	51.753	41.590	75.779	9.662	63.313	0.948	64.197
3.83	17.856	52.209	42.326	63.230	6.457	61.058	0.287	61.234
4.00	17.863	52.227	42.355	52.290	4.236	58.874	-0.588	58.257
4.50	16.657	48.702	36.830	45.469	3.683	51.194	-1.583	49.610
5.00	15.304	44.748	31.092	38.386	3.109	43.218	-1.599	41.619
5.50	13.950	40.736	25.831	31.890	2.583	35.905	-1.599	34.306
6.00	12.595	36.825	21.057	25.996	2.106	29.269	-1.599	27.670
6.50	11.240	32.863	16.770	20.704	1.677	23.310	-1.599	21.711
7.00	9.885	28.902	12.971	16.013	1.297	18.029	-1.599	16.430
7.50	8.530	24.940	9.659	11.924	0.966	13.426	-1.599	11.826
8.00	7.175	20.979	6.834	8.437	0.683	9.499	-1.599	7.900
8.50	5.820	17.017	4.497	5.552	0.450	6.250	-1.599	4.651
9.00	4.465	13.056	2.647	3.268	0.265	3.679	-1.599	2.080
9.50	3.110	9.094	1.234	1.586	0.128	1.785	-1.599	0.186
10.00	1.756	5.133	0.409	0.505	0.041	0.569	-1.599	-1.031
10.50	0.401	1.171	0.021	0.026	0.002	0.030	-1.599	-1.570
11.00	-0.843	-2.430	0.096	0.096	0.010	0.133	-1.175	-1.444
11.50	-1.472	-4.304	0.288	0.288	0.029	0.400	-0.299	-0.836
12.00	-1.417	-4.144	0.267	0.267	0.027	0.371	2.649	-0.093

```
DO YOU NEED TO STOPE THE OUTPUT IN A DATA FILE?Y OR N
=N


ENTEP PEPUN OP STOP
=PEPUN
PEPUN OPTION PEPMITS YOU TO CHANGE ANY OP ALL INPUT VAPIABLES.
AT >>>= QUE TYPE IN THE TWO LETTEPS(AA,AB,ETC.) COPPESPONDING
TO THE VAPIABLES YOU WISH TO CHANGE.  THEN AT NEXT = QUE, ENTEP
THE NUMEPICAL VALUE.  TO TERMINATE DATA ENTPY, TYPE A CAPPIAGE
PETUPN AT >>>= QUE.
```

```
>>>
=AB
AB-ENTER YOUR PROBLEM NAME
=EXAMPLE 2
>>>
=AC
AC-ENTER TOTAL NO. OF CALC. STEPS DESIRED
=31
>>>
=AV
AV-ENTER FIRST VALVE RATE
=1
>>>
=AW
AW-ENTER TIME VALVE STOPS MOTION(MINUTES)
=.5
>>>
=AX
AX-ENTER DURATION OF STOP(MINUTES)
=2
>>>
=AY
AY-ENTER FINAL VALVE RATE
=3
>>>
=DA
DA-ENTER 2ND OUTPUT CONTROL; 1=DO,0=DO NOT PRINT
=0
>>>
=


EXAMPLE 2

CONDUIT GEOMETRY: LENGTH =    392.0 FT.  WIDTH=  12.0 FT.
                  HEIGHT= 14.0 FT.   N= 2-CULVERT OPERATION)

CHAMBER GEOMETRY: LENGTH = 635.4 FT.  WIDTH = 86.0 FT.

LOSS COEFFICIENT: INTAKE  0.200
        UPSTREAM CONDUIT  0.060
      DOWNSTREAM CONDUIT  0.180
                MANIFOLD  0.850
       TOTAL(VALVE OPEN)  1.390   LOCK COEF.=0.848

ELEVATIONS: UPPER POOL 262.80
            LOWER POOL 169.50
          CULVERT ROOF 123.00


VALVE OPENS AT   1.00-MIN. RATE FOR   0.50 MINUTES
VALVE HOLDS FOR  2.00-MIN. AT  5.32FT.;
THEN OPENS AT  3.00-MIN. RATE TO FULL OPEN
TOTAL VALVE TIME =  4.17-MIN. (N= 26)



ACC.VEL. ERROR TO I= 31 IS   0.01400
ACC.VEL. ERROR TO I= 31 IS   0.01400
LOCK OPERATION IS NOT COMPLETE
LOCK DOES NOT COMPLETE OVERTRAVEL
```

	VALVE PARAMETERS				ELEVATIONS (FT-DATUM)				
TIME (M)	OPEN. RATIO	CONT. COEF.	LOSS COEF.	TOTAL INFLOW CFS	LOCK CHAMBER	US VALVE WELL	PIEZ.HD VALVE	DS VALVE WELL	CAV.PAR.
0.	0.	0.80	10000.00	0.	169.50	262.80	169.50	169.50	9.99
0.17	0.11	0.78	127.64	2190.	169.69	261.97	166.66	170.25	0.88
0.33	0.23	0.70	29.23	4453.	170.25	259.36	157.58	172.57	0.71
0.50	0.38	0.65	9.64	7548.	171.27	252.93	133.88	177.93	0.39
0.67	0.38	0.65	9.64	7737.	172.56	252.43	127.37	179.56	0.32
0.83	0.38	0.65	9.64	7699.	173.87	252.53	128.69	180.80	0.33
1.00	0.38	0.65	9.64	7644.	175.17	252.67	130.60	182.01	0.35
1.17	0.38	0.65	9.64	7588.	176.47	252.82	132.54	183.20	0.37
1.33	0.38	0.65	9.64	7531.	177.75	252.97	134.47	184.38	0.40
1.50	0.38	0.65	9.64	7475.	179.02	253.12	136.38	185.55	0.42
1.67	0.38	0.65	9.64	7418.	180.29	253.26	138.29	186.72	0.44
1.83	0.38	0.65	9.64	7362.	181.54	253.41	140.17	187.88	0.46
2.00	0.38	0.65	9.64	7305.	182.78	253.55	142.05	189.02	0.48
2.17	0.38	0.65	9.64	7249.	184.02	253.69	143.90	190.16	0.51
2.33	0.38	0.65	9.64	7193.	185.24	253.83	145.75	191.29	0.53
2.50	0.38	0.65	9.64	7040.	186.45	254.21	150.67	192.24	0.60
2.67	0.44	0.66	6.32	8200.	187.74	251.15	150.01	195.60	0.59
2.83	0.50	0.67	4.03	9645.	189.26	246.68	146.19	200.13	0.53
3.00	0.56	0.69	2.51	11241.	191.03	240.90	143.75	205.80	0.50
3.17	0.63	0.72	1.52	12873.	193.07	234.08	144.83	212.45	0.51
3.33	0.70	0.74	0.91	14388.	195.39	226.93	150.73	219.59	0.60
3.50	0.77	0.78	0.53	15629.	197.93	220.47	161.31	226.49	0.77
3.67	0.85	0.82	0.31	16501.	200.66	215.61	174.88	232.49	1.08
3.83	0.92	0.86	0.18	16992.	203.50	212.76	189.14	237.25	1.53
4.00	1.00	0.90	0.10	17201.	206.40	211.52	201.98	240.99	2.16
4.17	1.00	0.90	0.10	16922.	209.29	213.18	203.94	242.77	2.27
4.67	1.00	0.90	0.10	15647.	217.59	220.37	212.47	246.21	2.86

```
DO YOU NEED TO STORE THE OUTPUT IN A DATA FILE?Y OR N
=Y
ENTER A 5-LETTER FILE NAME
=DLK1
YOUR OUTPUT VALUES ARE STORED IN FILE DLK1

ENTER RERUN OR STOP
=STOP
```

REF: ER 1110-1-10 - ENGINEERING AND DESIGN - Engineering and Computer Program Library Standards and Documentation, Appendix C

PART III: FILE DOCUMENTATION

1. REVISION LOG: N/A

2. TITLE: H5320 - Lock Filling and Emptying - Symmetrical Systems

3. SOURCE PROGRAM LISTINGS: See pages 41-52

4. NUMERICAL AND LOGICAL ANALYSIS: A finite difference scheme is used to determine the flow rate through the culverts and water surface elevation in the chamber during a lock operation.

5. SUBROUTINES NOT DOCUMENTED IN ABSTRACT: None

6. MISCELLANEOUS: The program is part of the CORPS computer system. CORPS is an acronym standing for Conversationally Oriented Real-Time Program-Generating System. The program is now operational on the WES G635, Vicksburg, MS; HIS 66/8Ø, Macon, GA, and Boeing CDC, Seattle, WA. The source listing on page 41 contains the first line run command and brief for H5320. This first line run command runs the binary H5320B of the source listing on pages 42-52 (Fortran source of H5320) and attaches the WESLIB routines HACCT and RERUN.

06/23/78

H5320

```
0001*#RUN WESLIB/H5320B,R;WESLIB/RERUN,R;WESLIB/HACCT,R
0300 03NO BRIEF
0999*06FINISH
```

06/22/78

H5320S

```
#RUN *=;WESLIB/H5320B,R(NOGO)
CHARACTER*5 HFILE
COMMON LQZ,LQX
HFILE=5HH5320
LQZ=1;LQX=1
PRINT 10
10 FORMAT(/"H5320 - LOCK FILLING AND EMPTYING-SYMMETRICAL SYSTE
&MS"//)
15000 CONTINUE
CALL HACCT(HFILE)
IF(LQZ.EQ.1) CALL H5320($16000)
GO TO(20,30),LQZ
30 CALL DATAF($16000)
CALL MAIN1($16000)
PRINT," "
20 LQZ=2
CHARACTER ZZZZZZ*2
16000 PRINT, "ENTER RERUN OR STOP"
READ 16001, ZZZZZZ
16001  FORMAT(A2)
IF(ZZZZZZ.EQ.2HRE) GO TO 15000
IF(ZZZZZZ.EQ.2HST) GO TO 20000
PRINT,"ERROR *** RETYPE"
GO TO 16000
20000  STOP;END
SUBROUTINE H5320(*)
COMMON LQZ,LQX,XBB(201),TYPE,RUN,XN,ZU,ZL,ZP,XL1,XL2,XL3,XL4,XL5,
&XK1,XK2,XK3,XK4,DTS,M,IVALV,N,BB1,AAB,TV1,T1,TLAG,TV2,AAC,SAG,IPR
&IN1,IPRIN2,IDEL1,IDEL2,NSTART,KK,IVAL1,IVAL2,LINE(201)
DIMENSION XT(201),XKV(201),XCC(201),Q(201),RR(201),Z(201),ZUW(201)
&,ZV(201),ZDW(201),V(201),VH(201),HL1(201),HL2(201),HLV(201),HL3(20
&1),HL4(201),HLT(201),HI(201),H(201),XK(201),CI(201),VHVC(201)
CHARACTER RUN*35,AAA*1,AAB*8,AAC*10,AAD*8,AAE*10,CFILE*25
DATA B,C,D,E,F,CI(1),XKV(1)/2.2,3.2,.65,.8,.9,9.99,10000.0/
KK=0;IVAL1=0;IVAL2=0
10090 FORMAT(3X,3F8.3/3X,5F8.3/3X,4F8.3/3X,F5.1,2I4,5I2)
10100 FORMAT(3X,2F4.0,A35)
10110 FORMAT(3X,10F6.3)
10120 FORMAT("CONDUIT GEOMETRY: LENGTH = ",F7.1," FT.  WIDTH= ",
&F5.1," FT.",/,13X,"HEIGHT=",F5.1," FT.  N=",I2,
&"-CULVERT OPERATION)",//,"CHAMBER GEOMETRY:",
&" LENGTH =",F6.1," FT.  WIDTH =",F5.1," FT.",//,"LOSS ",
&"COEFFICIENT: INTAKE",F7.3,/,9X,"UPSTREAM CONDUIT",F7.3,/,
&7X,"DOWNSTREAM CONDUIT",F7.3,/,17X,"MANIFOLD",F7.3,/,3X,"TOTAL
&(VALVE OPEN)",F7.3,"   LOCK COEF.=",F5.3,//,
&"ELEVATIONS: UPPER POOL",F7.2,/,13X,"LOWER POOL",
&F7.2,/,11X,"CULVERT ROOF",F7.2)
10210 FORMAT(//,"VALVE OPENS AT",F7.2,"-MIN. RATE FOR",F7.2,
&" MINUTES")
10230 FORMAT("VALVE HOLDS FOR",F6.2,"-MIN. AT",F6.2,"FT.;",/,
```

H5320S CONT.

```
&"THEN OPENS AT",F6.2,"-MIN. RATE TO FULL OPEN",/,
&"TOTAL VALVE TIME =",F6.2,"-MIN. (N=",I3,")"//)
10260 FORMAT(/,"SPECIAL VALVING,TIME=",F7.2,"-MIN."//)
10270 FORMAT("EXTREME ELEVATION AT TIME =",
&F6.2," MINUTES",/,"MAX COMPUTED OVERTRAVEL =",F5.2," FT.")
10290 FORMAT(//,6X,"VALVE PARAMETERS",15X,"ELEVATIONS (FT-DATUM)"/
&"TIME OPEN. CONT.  LOSS   TOTAL      LOCK   US VALVE PIEZ.HD DS",
&" VALVE"/" (M) RATIO  COEF.  COEF. INFLOW   CHAMBER  WELL"
&,"   VALVE    WELL",/,27X,"CFS",33X,"CAV.PAR.")
10330 FORMAT(F6.2,2F5.2,F9.2,F7.0,4F8.2,F5.2)
10340 FORMAT(9X,"RATE",10X,"VEL HDS(F)",10X,"DIFFERENTIAL HDS(F)"/
&,9X,"RISE  VEL.  REF.    VENA      VALVE TOTAL INERTIA OVERALL"/
&,8X,"(F/M) (F/S)  AREA    CONT.",11X,"LOSS"/)
10370 FORMAT(F6.2,3F7.3,3F8.3,F7.3,F8.3)
10380 FORMAT(//,"LOCK EMPTIES TO LOWER POOL IN ",F5.2," MINUTES")
10390 FORMAT(//,"LOCK FILLS TO UPPER POOL IN ",F5.2," MINUTES")
10400 FORMAT("ACC.VEL. ERROR TO I=",I3," IS",F10.5)
10410 FORMAT(//)
10420 FORMAT(A1,A8,A1)
10430 FORMAT(I3,3F6.2,F9.2,F7.0,4F7.2,4F6.2,5F7.2)
NSTART=0
PRINT,"DO YOU HAVE A PERMANENT DATA FILE?Y=YES;N=NO"
READ,AAA
IF(AAA.EQ.1HY)GO TO 10540
PRINT,"WE WILL HELP YOU SET UP YOUR DATA FILE"
PRINT,"YOU MUST SUPPLY 29 DATA ITEMS AND A FILE NAME"
PRINT,"ENTER YOUR NEW 5-LETTER FILE NAME"
READ,AAB
CALL DATAF($22275)
GO TO 10610
10540 PRINT,"ENTER YOUR 5-LETTER FILE NAME"
NSTART=1
10560 READ,AAB
IF(AAB.EQ.5HSTOP ) RETURN 1
GO TO 10610
10580 PRINT 10590,AAB
10590 FORMAT("NO FILE ",A8,". ENTER FILE NAME OR STOP")
GO TO 10560
*10610 ENCODE(AAC,10420) "/",AAB,";"
ENTRY MAIN1(*)
10630 CONTINUE
CALL ATTACH(1,AAC,3,0,ISTAT,)
CALL TEST(ISTAT,IDEC)
GO TO(10670,10580,941,941,10580),IDEC
10670 CONTINUE;KK=1
READ(1,10100) TYPE,XN,RUN
READ(1,10090) ZU,ZL,ZR,XL1,XL2,XL3,XL4,XL5,
&XK1,XK2,XK3,XK4,DTS,M,N,IVALV,IPRIN1,IPRIN2,IDEL1,IDEL2
IF(ABS(TYPE).LT.0.99.OR.ABS(TYPE).GT.1.01)GO TO 294
IF(IVALV.EQ.2)GO TO 10750
```

H5320S CONT.

```
READ(1,10110,END=10770)(XBB(I),I=1,N)
GO TO 10770
10750 READ(1,10110,END=10760)SAG,TV1,T1,TLAG,TV2
10760 CALL VAL2(SAG,TV1,T1,TLAG,TV2,DTS,N,BB1,XBB)
10770 IF(NSTART.EQ.0)GO TO 10320
PRINT,"DO YOU WISH TO CHANGE ANY DATA BEFORE YOU START? YES OR NO?
&"
READ,AAA;IF(AAA.EQ.1HY) KK=1
IF(AAA.EQ.1HY) CALL RUN1($10630)
10320 CONTINUE
NSTART=0
DTM=DTS/60.0;T3=(N-1)*DTM;NC=XN;AR=(XN*XL2*XL3)/(XL4*XL5)
DO 10930 I=2,M+1
IF(I.GT.N)XBB(I)=XBB(I-1)
XT(I)=XT(I-1)+DTM
IF(XBB(I).LE.0.2) XKV(I)=(10.0**(B-.2*C))*(0.04/XBB(I)**2)
IF(XBB(I).GE.0.2) XKV(I)=10.0**(B-C*XBB(I))
IF(XBB(I).LE.0.3) XCC(I)=D+(E-D)*COS(3.141593*(XBB(I)/0.60))
IF(XBB(I).GE.0.3) XCC(I)=F-(F-D)*COS(((XBB(I)-.3)*3.141593)/1.4)
XK(I)=XK1+XK2+XK3+XK4+XKV(I)
10930 CONTINUE
XKT=XK1+XK2+XK3+XK4+10.0**(B-C)
XKC=SQRT(1/XKT);PRINT 10950,RUN;10950 FORMAT(/A35//)
IF(IPRIN1.EQ.1)PRINT 10120,XL1,XL2,XL3,NC,XL4,XL5,
&XK1,XK2,XK3,XK4,XKT,XKC,ZU,ZL,ZR
BB2=XL3*BB1
IF(IVALV.EQ.2)PRINT 10210,TV1,T1
IF(IVALV.EQ.2.AND.T1.LT.TV1)PRINT 10230,TLAG,BB2,TV2,T3,N
IF(IVALV.EQ.1)PRINT 10260,T3
C SET INITIAL CONDITIONS
IF(TYPE)11040,11060,11060
11040 Z(1)=ZU;ZREF=ZL;ZDW(1)=ZU
GO TO 11070
11060 Z(1)=ZL;ZREF=ZU;ZDW(1)=ZL
11070 CONTINUE
XCC(1)=E;M1=M;M2=M;ZUW(1)=ZU;ZOT=0.0;ZV(1)=ZL
M3=M
H(1)=ZU-ZL;HLV(1)=H(1);HLT(1)=H(1)
C START NUMERICAL INTEGRATION
DO 11270 I=1,M-1
V(I+1)=PRED(Z(I),V(I),XK(I+1),TYPE,ZREF,AR,DTS,XL1)
Z(I+1)=ZNEW(Z(I),V(I),V(I+1),AR,DTS,TYPE)
IF(ABS(XL1*(V(I+1)-V(I))).GE..5*XK(I+1)*DTS*V(I+1)**2)M3=I-1
IF(I.GT.M3.OR.I.GT.M1)GO TO 11250
DO 11230 J=1,10
V(I+2)=PRED(Z(I+1),V(I+1),XK(I+2),TYPE,ZREF,AR,DTS,XL1)
V(I+1)=CORR(Z(I),V(I),XK(I+1),V(I+2),TYPE,ZREF,AR,DTS,XL1)
ZCHEC=ZNEW(Z(I),V(I),V(I+1),AR,DTS,TYPE)
IF(ABS(ZCHEC-Z(I+1)).LE.0.0001)GO TO 11240
Z(I+1)=ZCHEC
```

H5320S CONT.

```
11230 CONTINUE
11240 Z(I+1)=ZCHEC
11250 IF(M2.EQ.M.AND.V(I+1).LT.0.0)M2=I
IF(M1.EQ.M.AND.TYPE*(ZREF-Z(I+1)).LE.0.0) M1=I
11270 CONTINUE
ERROR=0.0
PRINT 10410
DO 11350 I=2,M2
YY=CORR(Z(I-1),V(I-1),XK(I),V(I+1),TYPE,ZREF,AR,DTS,XL1)
ERROR=(YY-V(I))**2+ERROR
IF(I.EQ.M1)PRINT 10400,I,ERROR
IF(I.EQ.M2)PRINT 10400,I,ERROR
11350 CONTINUE
C END OF DIFF.EQNS.
DO 11690 I=2,M
VH(I)=(V(I)**2)/64.4
Q(I)=V(I)*XL2*XL3*XN
RR(I)=(Q(I)*60.0)/(XL4*XL5)
HI(I)=XL1*(V(I+1)-V(I-1))/(64.4*DTS)
HL1(I)=XK1*VH(I)
HL2(I)=XK2*VH(I)
HLV(I)=XKV(I)*VH(I)
HL3(I)=XK3*VH(I)
HL4(I)=XK4*VH(I)
HLT(I)=XK(I)*VH(I)
H(I)=TYPE*(ZREF-Z(I))
IF(V(I).GE.0.0)VHVC(I)=VH(I)/(XCC(I)*XBB(I))**2
IF(V(I).LT.0.0)VHVC(I)=VH(I)
IF(TYPE)11590,11590,11520
11520 IF(V(I).GT.0.0)ZUW(I)=ZU-(1.0+XK1+XK2)*VH(I)
IF(V(I).LE.0.0)ZUW(I)=ZU-(1.0-XK1-XK2)*VH(I)
IF(V(I).GE.0.0)ZDW(I)=Z(I)+XK4*VH(I)
IF(V(I).LT.0.0)ZDW(I)=Z(I)-XK4*VH(I)
IF(V(I).GT.0.0)ZV(I)=ZUW(I)+VH(I)-VHVC(I)
IF(V(I).LE.0.0)ZV(I)=ZUW(I)-VHVC(I)
GO TO 11640
11590 ZUW(I)=ZU
IF(V(I).GE.0.0)ZDW(I)=Z(I)-(1.0+XK1+XK2)*VH(I)
IF(V(I).LT.0.0)ZDW(I)=Z(I)-(1.0-XK1-XK2)*VH(I)
IF(V(I).GE.0.0)ZV(I)=ZDW(I)+VH(I)-VHVC(I)
IF(V(I).LT.0.0)ZV(I)=ZDW(I)-VHVC(I)
11640 CONTINUE
IF(V(I).LE.0.0)CI(I)=9.99
IF(V(I).GT.0.0)CI(I)=(ZV(I)-ZP+XL3*(1.-XCC(I)*XBB(I)))/VHVC(I)
&+33.0/VHVC(I)
IF(CI(I).GE.10.0)CI(I)=9.99
11690 CONTINUE
XTX=XT(M1)+DTM*(ZREF-Z(M1))/(Z(M1+1)-Z(M1))
XTM=XT(M2)
ZOT=Z(M2)-ZREF
```

H53205 CONT.

```
IF(M1.EQ.M)PRINT,"LOCK OPERATION IS NOT COMPLETE"
IF(M2.EQ.M)PRINT,"LOCK DOES NOT COMPLETE OVERTRAVEL"
IF(M1.LT.M.AND.TYPE.GT.0.0)PRINT 10390,XTX
IF(M1.LT.M.AND.TYPE.LT.0.0)PRINT 10380,XTX
IF(M2.LT.M)PRINT 10270,XTM,ZOT
PRINT 10290
PRINT 10330,(XT(I),XBB(I),XCC(I),XKV(I),Q(I),Z(I),ZUW(I),
&ZV(I),ZDW(I),CI(I),I=1,N,IDEL1)
PRINT 10330,(XT(I),XBB(I),XCC(I),XKV(I),Q(I),Z(I),ZUW(I),
&ZV(I),ZDW(I),CI(I),I=N+IDEL2,M,IDEL2)
IF (IPRIN2)11900,11900,11840
11840 CONTINUE
PRINT 10340
PRINT 10370,(XT(I),RR(I),V(I),VH(I),VHVC(I),HLV(I),HLT(I),
&HI(I),H(I),I=1,N,IDEL1)
PRINT 10370,(XT(I),RR(I),V(I),VH(I),VHVC(I),HLV(I),HLT(I),
&HI(I),H(I),I=N+IDEL2,M,IDEL2)
11900 CONTINUE
PRINT,"DO YOU NEED TO STORE THE OUTPUT IN A DATA FILE?Y OR N"
READ,AAA
IF(AAA.EQ.1HN)GO TO 320
PRINT,"ENTER A 5-LETTER FILE NAME"
READ,AAD
LINE(1)=100
DO 11980 I=2,M
11980 LINE(I)=LINE(I-1)+2
ENCODE(AAE,10420)"/",AAD,";"
ENCODE(CFILE,59) "CF,/",AAD,",B/1,35/,R,W#"
CALL ATTACH(2,AAE,3,0,ISTAT,)
CALL TEST(ISTAT,IDEC)
GO TO(172,173,175,175,175),IDEC
173 CALL ACCESS(CFILE,$175)
172 CONTINUE
CALL ATTACH(2,AAE,3,,)
CALL HEADER(M)
DO 12075 I=1,M;12075 XKV(I)=ALOG10(XKV(I))
WRITE(2,10430) (LINE(I),XT(I),XBB(I),XCC(I),XKV(I),Q(I),Z(I),
&ZUW(I),ZV(I),ZDW(I),CI(I),RR(I),V(I),VH(I),VHVC(I),HLV(I),
&HLT(I),HI(I),H(I),I=1,M)
61 CALL DETACH(2,,)
PRINT 160,AAD
160 FORMAT("YOUR OUTPUT VALUES ARE STORED IN FILE ",A8)
59 FORMAT(A4,A8,A13)
GO TO 320
175 PRINT,"FILE PROBLEM;ILLEGAL CHAR;BUSY;OR SYSTEM PROBLEM"
PRINT,"OUTPUT VALUES NOT SAVED AS REQUESTED"
320 CONTINUE
GO TO 293
294 PRINT,"PROGRAMMED STOP;TYPE NOT EQUAL 1 OR -1";RETURN 1
941 PRINT 946,ISTAT
```

H5320S CONT.

```
946 FORMAT("FILE PROBLEM. CALL FTS 542-2403 AND GIVE THIS NUMB
&ER ",O12)
293 CONTINUE
CALL DETACH(1,,);RETURN
22275 RETURN 1
END
FUNCTION PRED (ZST,VST,XKF,TYPE,ZREF,AR,DTS,XL1)
XC=(64.4/XKF)*(TYPE*(ZREF-ZST)-VST*(.5*AR*DTS-XL1/(32.2*DTS)))
XB=(64.4/XKF)*(.5*AR*DTS+XL1/(32.2*DTS))
IF(XC.GE.0.0)PRED=-.5*XB+.5*SQRT(XB**2+4.*XC)
IF(XC.LT.0.0)PRED=.5*XB-.5*SQRT(XB**2-4.*XC)
RETURN;END
FUNCTION CORR (ZST,VST,XKF,VAH,TYPE,ZREF,AR,DTS,XL1)
XC=(64.4/XKF)*(TYPE*(ZREF-ZST)-.5*VST*AR*DTS-XL1*(VAH-VST)/
&(64.4*DTS))
XB=32.2*AR*DTS/XKF
IF(XC.GE.0.0)CORR=-.5*XB+.5*SQRT(XB**2+4.*XC)
IF(XC.LT.0.0)CORR=.5*XB-.5*SQRT(XB**2-4.*XC)
RETURN;END
FUNCTION ZNEW (ZST,VST,VF,AR,DTS,TYPE)
ZNEW=ZST+TYPE*.5*AR*DTS*(VST+VF)
RETURN;END
SUBROUTINE TEST(ISTAT,IDEC)
DIMENSION ITEST(5)
DATA ITEST/000,005,037,004,034/
IDEC=3
ISTAT=FLD(6,6,ISTAT)
IF(ISTAT.EQ.ITEST(3).OR.ISTAT.EQ.ITEST(1)) IDEC=1
IF(ISTAT.EQ.ITEST(2)) IDEC=2
IF(ISTAT.EQ.ITEST(4)) IDEC=4
IF(ISTAT.EQ.ITEST(5)) IDEC=5
RETURN;END
SUBROUTINE VAL2(A,TV1,T1,TLAG,TV2,DTS,N,BB1,XBB)
DIMENSION XT(201),XBB(201)
T2S=0.0;BB1=0.0;DTM=DTS/60.0;XT(1)=0.0;PI=3.141593
IF(TV1-DTM)182,186,186
182 PRINT,"YOUR 1ST VALVE RATE IS LESS THAN ONE TIME STEP"
PRINT,"ENTER VALVE OPENING RATIO AT END OF 1ST TIME STEP"
READ,BB1
T1=0.0
186 CONTINUE
IF(TV1.GE.DTM)BB1=T1/TV1-A*SIN(PI*T1/TV1)
T2S=BB1*TV2
DO 214 J=1,6
T2N=T2S+(TV2*BB1-T2S+A*TV2*SIN(PI*T2S/TV2))/
&(1.0-A*PI*COS(PI*T2S/TV2))
IF(ABS(T2N/T2S-1.0).LE.0.0001) GO TO 215
214 T2S=T2N
215 CONTINUE
T2=T1+TLAG
```

```
T3=T2-T2S+TV2
N=T3/DTM+2
DO 52 I=2,N
XT(I)=XT(I-1)+DTM
IF(XT(I).LE.T1)XBB(I)=XT(I)/TV1-A*SIN(PI*XT(I)/TV1)
IF(XT(I).GT.T1.AND.XT(I).LE.T2)XBB(I)=BB1
IF(XT(I).GT.T2)XBB(I)=(XT(I)-T2+T2S)/TV2-A*SIN(PI*(XT(I)-T2+T2S)
&/TV2)
52 CONTINUE
IF(XBB(N).GT.1.0)XBB(N)=1.0
RETURN;END
SUBROUTINE DATAF(*)
COMMON LQZ,LQX,XBB(201),TYPE,RUN,XN,ZU,ZL,ZR,XL1,XL2,XL3,XL4,XL5,
&XK1,XK2,XK3,XK4,DTS,M,IVALV,N,BB1,AAB,TV1,T1,TLAG,TV2,AAC,SAG,IPR
&IN1,IPRIN2,IDEL1,IDEL2,NSTART,KK,IVAL1,IVAL2,LINE(201)
CHARACTER RUN*35,AAB*8,AAC*10,CFILE*24
IF(LQX.EQ.3) GO TO 11520
ENTRY RUN1(*)
IF(LQZ.EQ.2) GO TO 11520
CALL PRINTT
IF(NSTART.EQ.0) GO TO 11520
LQZ=2;REWIND 1
11520 KKK=29
GO TO(111,112),LQZ
112 CALL RERUN(KKK,LQX,JKL)
GO TO(1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,
&24,25,26,27,28,29,30),JKL
111 CONTINUE
GO TO(1,112),LQZ
1 PRINT,"AA-ENTER 1=FILL;OR -1=EMPTY;OR 0=TERMINATE NOW"
READ,TYPE
IF(ABS(TYPE).LT.0.99)GO TO 174
GO TO(2,112),LQZ
2 PRINT,"AB-ENTER YOUR PROBLEM NAME"
READ 33,RUN
33 FORMAT(A35)
GO TO(3,112),LQZ
3 PRINT,"AC-ENTER 1=1-CULV.;OR 2=2-CULV. OPERATION"
READ,XN
GO TO(4,112),LQZ
4 PRINT,"AD-ENTER UPPER POOL ELEVATION"
READ,ZU
GO TO(5,112),LQZ
5 PRINT,"AE-ENTER LOWER POOL ELEVATION"
READ,ZL
GO TO(6,112),LQZ
6 PRINT,"AF-ENTER CULV. ROOF ELEVATION"
READ,ZR
GO TO(7,112),LQZ
7 PRINT,"AG-ENTER CULV. LENGTH"
```

H5320S CONT.

```
READ,XL1
GO TO(3,112),LQZ
3 PRINT,"AH-ENTER CULV. WIDTH"
READ,XL2
GO TO(9,112),LQZ
9 PRINT,"AI-ENTER CULV. HEIGTH"
READ,XL3
GO TO(10,112),LQZ
10 PRINT,"AJ-ENTER CHAMBER LENGTH"
READ,XL4
GO TO(11,112),LQZ
11 PRINT,"AK-ENTER CHAMBER WIDTH"
READ,XL5
GO TO(12,112),LQZ
12 PRINT,"AL-ENTER CULV. INTAKE LOSS COEF."
READ,XK1
GO TO(13,112),LQZ
13 PRINT,"AM-ENTER U-S CULV. LOSS COEF."
READ,XK2
GO TO(14,112),LQZ
14 PRINT,"AN-ENTER D-S CULV. LOSS COEF."
READ,XK3
GO TO(15,112),LQZ
15 PRINT,"AO-ENTER CULV. EXIT LOSS COEF."
READ,XK4
GO TO(16,112),LQZ
16 PRINT,"AP-ENTER TIME STEP IN SECONDS"
READ,DTS
GO TO(17,112),LQZ
17 PRINT,"AQ-ENTER TOTAL NO. OF CALC. STEPS DESIRED"
READ,M
GO TO(18,112),LQZ
18 PRINT,"AR-ENTER TYPE OF VALVING(1 OR 2;SEE TABLE)"
READ,IVALV
IF(IVALV.EQ.2) GO TO 50
GO TO(19,11556),LQZ
11556 LQZ=1
19 PRINT,"AS-ENTER NO. OF RATIOS TO BE ENTERED"
READ,N
GO TO(20,112),LQZ
20 PRINT,"AT-ENTER VALVE RATIOS(SEP. BY COMMAS)"
READ,(XBB(I),I=1,N)
IF(IVAL1.EQ.0.AND.IVAL2.EQ.1) LQZ=2
IVAL1=1
IF(KK.EQ.1) LQZ=2
GO TO 60
50 GO TO(21,11591),LQZ
11591 LQZ=1
21 PRINT,"AU-ENTER VALVE SAG"
READ,SAG
```

06/23/78

H5320S CONT.

```
GO TO(22,112),LQZ
22 PRINT,"AV-ENTER FIRST VALVE RATE"
READ,TV1
GO TO(23,112),LQZ
23 PRINT,"AW-ENTER TIME VALVE STOPS MOTION(MINUTES)"
READ,T1
GO TO(24,112),LQZ
24 PRINT,"AX-ENTER DURATION OF STOP(MINUTES)"
READ,TLAG
GO TO(25,112),LQZ
25 PRINT,"AY-ENTER FINAL VALVE RATE"
READ,TV2
IF(IVAL1.EQ.1.AND.IVAL2.EQ.0) LQZ=2
IVAL2=1
IF(KK.EQ.1) LQZ=2
60 CONTINUE
GO TO(26,112),LQZ
26 PRINT,"AZ-ENTER 1ST OUTPUT CONTROL; 1=DO,0=DO NOT PRINT"
READ,IPRIN1
GO TO(27,112),LQZ
27 PRINT,"BA-ENTER 2ND OUTPUT CONTROL; 1=DO,0=DO NOT PRINT"
READ,IPRIN2
GO TO(28,112),LQZ
28 PRINT,"BB-ENTER FIRST OUTPUT RATE; 1=EVERY VALUE"
READ,IDEL1
GO TO(29,112),LQZ
29 PRINT,"BC-ENTER FINAL OUTPUT RATE; 2=EV. 2ND VALUE"
READ,IDEL2
GO TO(30,112),LQZ
30 CONTINUE
LINE(1)=100
DO 54 J=2,N/10+6
54 LINE(J)=LINE(J-1)+2
ENCODE(AAC,55)"/",AAB,";"
DO 62 J=N+1,N+10
62 XBB(J)=XBB(J-1)
ENCODE(CFILE,59)"CF,/",AAB,",B/1,3/,R,W#"
CALL ATTACH(1,AAC,3,0,ISTAT,)
CALL TEST(ISTAT,IDEC)
GO TO(172,173,175,175,175),IDEC
173 CALL ACCESS(CFILE,$175)
172 CONTINUE
CALL ATTACH(1,AAC,3,,)
WRITE(1,56)LINE(1),TYPE,XN,RUN,LINE(2),ZU,ZL,ZP,LINE(3),
&XL1,XL2,XL3,XL4,XL5,LINE(4),XK1,XK2,XK3,XK4,LINE(5),DTS,
&M,N,IVALV,IPRIN1,IPRIN2,IDEL1,IDEL2
DO 58 J=1,N/10+1
IF(IVALV.EQ.2)WRITE(1,57)LINE(6),SAG,TV1,T1,TLAG,TV2
IF(IVALV.EQ.2)GO TO 61
58 WRITE(1,57)LINE(J+5),(XBB(I),I=10*J-9,10*J)
```

06/23/78

H5320S CONT.

```
61 CALL DETACH(1,,)
55 FOPMAT(A1,A8,A1)
59 FOPMAT(A4,A8,A12)
56 FOPMAT(I3,2F4.0,A35,/,I3,3F8.3,/,I3,5F8.3,/,I3,4F8.3,/,
&I3,F5.1,2I4,5I2)
57 FOPMAT(I3,10F6.3)
GO TO 200
174 PPINT,"PROGPAMMED STOP;TYPE=0;PEVIEW YOUR DATA"; PETUPN 1
175 PPINTFILE PPOBLEMS;ILLEGAL CHAPACTEP;BUSY;OF SYSTEM PPOB."
200 IF(NSTAPT.EQ.1) GO TO 1192
PETUPN
1192 NSTAPT=0;LOZ=1;PETUPN 1;END
SUBPOUTINE PPINTT
CHAPACTEP AAA*1
PPINT,"SHOULD I PPINT A TAELE OF INPUT CODES?Y=YES;N=NO"
PEAD,AAA
IF(AAA.EQ.1HN)GO TO 4
PPINT 2
2 FOPMAT("CODE VAPIAELE",17X,"DESCPIPTION"/
&"AA  TYPE",3X,"1=FILL;-1=EMPTY;0=TEPMINATE PUN"/
&"AB  PUN",4X,"PPOELEM NAME(35 SPACES AVAILAELE)"/
&"AC  XN",5X,"1=ONE CULV.;2=TWO CULVEPT OPEPATION"/
&"AD  ZU",5X,"UPPEP POOL ELEV.(FT-DATUM)"/
&"AE  ZL",5X,"LOWEP POOL ELEV.(FT-DATUM)"/
&"AF  ZP",5X,"CULV. POOF ELEV.(FT-DATUM) AT VALVE"/
&"AG  XL1",4X,"CULV. LENGTH(FT)"/
&"AH  XL2",4X,"CULV. WIDTH(FT)"/
&"AI  XL3",4X,"CULV. HEIGTH(FT)"/
&"AJ  XL4",4X,"CHAMBEP LENGTH(FT)"/
&)
PPINT 3
3 FOPMAT(
&"AK  XL5",4X,"CHAMBEP WIDTH(FT)"/
&"AL  XK1",4X,"INTAKE LOSS COEF."/
&"AM  XK2",4X,"U-S CONDUIT LOSS COEF."/
&"AN  XK3",4X,"D-S CONDUIT LOSS COEF."/
&"AO  XK4",4X,"EXIT LOSS COEF."/
&/"NOTE:LOCK COEF.=SQUAPE POOT OF 1/(XK1+XK2+XK3+XK4+0.1)"//
&"AP  DTS",4X,"TIME STEP(SEC.) FOP CALCULATIONS"/
&"AQ  M",6X,"NO. OF STEPPED VALUES(INCL. TIME=0.0)"/
&"AP  IVALV",2X,"VALVE OPTIONS: 1=POINT-BY-POINT"/
&,25X,"2=USE PPOGPAMMED FUNCTIONS"/
&/"IF IVALV=1"//
&"AS  N",6X,"NO.OF VALUES OF VALVE OPENING PATIOS TO BE PEAD"/
&,11X,"(INCL.0.0 AT TIME=0.0 AND 1.0 AT VALVE FULL OPEN)"/
&,11X,"THESE VALUES APE DTS SEC. APAPT(SEE AP,ABOVE)"/
&"AT  XBB(I)",1X,"N VALUES(SEPAPATE WITH COMMAS) OF"
&/,11X,"VALVE OPENING PATIOS"/
&/"IF IVALV=2"//
&"AU  SAG",4X,"NOPMAL SAG AT 1/2 VALVE TIME(APPROX.=0.1)"/
```

H5320S CONT.

```
24730&)
24740 PRINT 6
24750 6 FORMAT(
24760&"AV  TV1",4X,"INITIAL OPENING RATE(MINS. TO FULLY OPEN)"/
24770&"AW  T1",5X,"VALVE MOTION STOPS AT T1 MINS."/
24780&"AX  TLAG",3X,"VALVE HOLDS POSITION FOR TLAG MINS."/
24790&"AY  TV2",4X,"FINAL OPENING RATE(MINS. TO FULLY OPEN)"/
24800&/"NOTE:NON-STEPPED OPENING; T1=TV1,TLAG=0.0,TV2=TV1"/
24810&/"NOTE:THE NEXT ITEMS CONCERN THE PRINTED OUTPUT"/
24820&"AZ  IPRIN1",1X,"1=PRINTS OUT ITEMS AA THRU AO,ABOVE"/
24830&,11X,"0=DO NOT PRINT ITEMS AA THRU AO"/
24840&"BA  IPRIN2",1X,"LOSS DISTRIBUTIONS; 1=PRINT,0=DO NOT PRINT"/
24850&"BB  IDEL1  PRINT 1ST AND EV. IDEL1*DTS SEC TO VALVE FULL OPEN"/
24860&"BC  IDEL2",2X,"PRINT EV. IDEL2*DTS SEC. TO (M-1)*DTS SEC."//)
24870 4 CONTINUE
24880 RETURN; END
24890 SUBROUTINE HEADER(M)
24900 14840 FORMAT("08 H5320 18 15 EDGE"/"09 (15(/),(3X,3F6.2,F9.2,F7.0,
24910&F7.2,4F6.2,5F7.2))"/"10",18(1X,I3)/"11",18("   1"))
24920 14860 FORMAT("12 CURVE DESIGNATIONS FOR H5320 ARE:"/"13  1=TIME",2
24930&4X,"10=CAVITATION PARAMETER"/"14  2=VALVE OPENING RATIO",9X,"11=RA
24940&TE-OF-RISE"/"15  3=CONTRACTION COEF.",11X,"12=VELOCITY AT REF AREA
24950&"/"16  4=LOG(VALVE LOSS COEF.)",7X,"13=VELOCITY HD AT REF AREA"/"1
24960&7  5=TOTAL INFLOW",16X,"14=VELOCITY HD AT VENA CONT"/"18  6=LOCK W
24970&ATER SURFACE(W-S)",5X,"15=HEADLOSS THRU VALVE"/"19  7=U/S VALVE WE
24980&LL W-S",10X,"16=TOTAL HEADLOSS"/"20  8=PIEZ HD BELOW VALVE",9X,"17
24990&=INERTIAL TERM"/"21  9=D/S VALVE WELL W-S",10X,"18=W-S DIFFERENTIA
25000&L"/"22 UNITS FOR ABOVE VARIABLES ARE:"/"23  MINUTES=1",8X,"FT/MIN
25010&=11"/"24  NONE=2,3,4,10",4X,"FT/SEC=12"/"25  CFS=5",12X,"FT=13,14,
25020&15,16,17,18"/"26  FT-DATUM=6,7,8,9")
25030 WRITE(2,14840) (M,I=1,18)
25040 WRITE(2,14860)
25050 RETURN
25060 END
```