Abbreviated Instructions for the Parameter-Estimation Package Input File

Compatible with MODFLOWP Version 3.0

Introduction and Purpose

These input instructions are intended to help the user construct and modify the Parameter-Estimation Package input file, by listing the input data and its description together. The instructions contain:

1) Abbreviated input instructions for the Parameter-Estimation Package input file, which contain:
a) lines and data sets from the modified input file for Test Case 1 of Hill (1992, Appendix A) (see below),
b) input formats and variable names for each input item (listed above the line or data set, and
c) abbreviated input instructions for each variable (listed below the line or data set).

2) The Parameter-Estimation Package input file for Test Case 1 presented in Appendix A of Hill (1992), modified by replacing the PID=KST parameter with a PID=KRB parameter, and by changing the input as necessary for compatibility with the version of MODFLOWP distributed with this release.

All data sets that can possibly be used in a Parameter-Estimation Package input file are described, including those that do not appear in the input file of Test Case 1 in Hill (1992, Appendix A). Data sets that do not appear in the test case are indicated by the phrase "not in example" listed below the data set.

The abbreviated input instructions do not contain the detail provided in the input instructions of Hill (1992) and the ’read-me.doc’ file accompanying the latest version of MODFLOWP. Consult the complete input instructions (Hill, 1992, p. 128-150) and the ’read-me.doc’ file for more detailed information about how a particular input variable is used in MODFLOWP. Page numbers from Hill (1992) are cited in the abbreviated input instructions to identify the location of additional information about certain complicated variables.

Abbreviated Instructions for the Parameter-Estimation Package Input File and Annotated Lines and Data Sets of the Input File

Lines 1 & 2: Title

	A80 TITLE
TWO-LAYER EXAMPLE - TRANSIENT	LINE 1
Modified Test Case 1 of Hill (1992, Appendix A)	LINE 2

Line 3: Data for dimensioning parameter definition arrays

I5 NP	I5 NSM	I5 NSN	I5 N2	I5 LZI1	I5 NMM	I5 NMP	I5 NZM	
9	5	56	4	2	1	0	1	LINE 3

NP = Number of parameters (includes estimated and fixed parameters)
NSM ≥ Total number of DATA SETS 2B.
NSN ≥ The sum of all |NCEL| in DATA SETS 2A.
N2 ≥ Largest number of values following LN (or PID, for RCH & ETM) for any DATA SET 2.
LZ1 ≥ Largest number of values used for any LZ vector of DATA SET 2B.
NMM = Number of multiplication arrays in DATA SET 3.
NMP = Number of lines in DATA SET 3A.
NZM = Number of zone arrays in DATA SET 4.

Line 4: Data used in checking the parameter definitions

I5 IPRNP	I5 ICHECK	I5 NUMR	
2	1	1	LINE 4

IPRNP = Output format code (See Hill, 1992, Table A2, p. 150) for model-input arrays produced by using initial parameter estimates for PID=T, KV, S1, RCH, or ETM.
ICHECK = Flag to check (ICHECK > 0) for cells that are repeated more than NUMR times in DATA SET 2 for model inputs defined by arrays.
NUMR = Number of times a cell can be repeated in defining a single model input array before an error message is printed.

Line 5: Data for dimensioning observation arrays and prior information

I5 NH	I5 MOBS	I5 MAXM	I5 NQ	I5 NQC	I5 NQT	I5 MPR	I5 IPR	
32	0	0	1	18	3	0	0	LINE 5

NH = Number of head (or change in head) observations.
MOBS = Number of the NH observations that are multilayer.
MAXM = Maximum number of layers used for any of the MOBS locations.
NQ = Number of cell groups for which there are head-dependent boundary flow observations.
NQC ≥ Sum of all |NQCL| in repetitions of DATA SET 7.
NQT ≥ Sum of all NQOB in repetitions of DATA SET 7.
MPR = Number of repetitions of DATA SET 12.
IPR = Number of parameters involved in the full weight matrix on parameters.

Line 6: Data to define what MODFLOWP calculates and how it is calculated.

I5 IPAR	I5 ISN	I5 ISCALS	I5 NOPT	I5 ISENS	
1	-1	1	0	0	LINE 6

IPAR = Flag identifying what to calculate (See Hill (1992, p. 110)):
IPAR < 0 --> Hydraulic heads
IPAR = 0 --> Hydraulic heads and sensitivity equations (ISN<0) or adjoint states (ISN>0)
IPAR > 0 --> Parameter estimation is performed

ISN = Flag identifying which optimization and numerical methods are used:
ISN < 0 --> Sensitivity-equation sensitivities calculated, estimation by modified Gauss-Newton.
ISN > 0 --> Adjoint-state method, estimation by conjugate-direction method.
See Hill (1992, p. 108-109) for allowable ISN values and their meanings.

ISCALS = Flag identifying whether printed sensitivities are scaled (ISCALS > 0) or not scaled (ISCALS ≤ 0). Scaling is performed by multiplying by the parameter value and the square root of the weight.

NOPT = Flag identifying whether (NOPT = 1) or not (NOPT = 0) to include R of equation (51) in equation (50a), as described in Hill (1992, p. 77). The user may want to set NOPT = 1 for problems with large residuals and a large degree of nonlinearity.

ISENS = Flag identifying which sensitivity arrays can be saved and printed when IPAR=0:
ISENS = 0 --> Only sensitivity arrays for time steps at which there are observations defined in DATA SETS 6 and 7.
ISENS = 1 --> Sensitivity arrays for all time steps.
Note: arrays are only saved and printed when HDSV and HDPR of the MODFLOW output control package input file so indicate. See Hill (1992, p. 153)

Line 7: Fortran unit numbers for input and output files

I5 IUHEAD	I5 IOUB	I5 IUBD	I5 IUNHEA	I5 IOUE	I5 IOUYR	I5 IUNORM	I5 IOUPRI	I5 IOUHDS	I5 IOUFLW	I5 IOSTAR	I5 IOWTQ	I5 IOUADV
40	33	0	0	0	0	0	0	0	0	0	0	0

IUHEAD = First output unit on which heads or sensitivities are stored in binary format. NP (LINE 3) sequentially numbered additional units are also opened when ISN=-1; NPER (BAS input file) additional units are opened when ISN=-2. See Hill (1992, p. 108-109, p. 153).

IOUB = For IOUB>0, estimated parameter values and statistics are printed at the end of the main output file, and are written to a separate output file with unit number IOUB. Generally, IOUB> 0.

IUBD = Input unit for IBOUND arrays. Needed if any cells go dry.

IUNHEA = Flag identifying whether there are (IUNHEA ≠ 0) temporal changes in head at constant head boundaries. See Hill (1992, p. 111) for more information.

IOUE = If IOUE>0, it is used to generate the files needed for the program BEALEP, as described in Hill (1994, p. 48-49).

IOUYR = If IOUYR>0, it is the unit number for output produced by program YR (Hill, 1994, p. 12-19). Use of IOUYR eliminates the need for program YR.

IUNORM= If IUNORM>0, it is the unit number for output produced by program NORM (Hill, 1994, p.19-22). Use of IUNORM eliminates the need for program NORM.

IOUPRI = If IOUPRI>0, it is the output file unit number in which the contents of the final tables 'PARAMETERS WITH PRIOR INFORMATION, BY GROUP' and 'PARAMETER SUMS WITH PRIOR INFORMATION' are written.

IOUHDS = If IOUHDS>0, it is the output file unit number in which the contents of the final table 'DATA AT HEAD LOCATIONS' are written.

IOUFLW = If IOUFLW>0, it is the output file unit number in which the contents of the final table 'DATA FOR FLOWS' are written.

IOSTAR = If IOSTAR=1, printing to the screen (unit * in Fortran) is omitted.

IOWTQ = Unit number on which the full covariance matrix on head-dependent flow observations is read. Input instructions for the file containing this full covariance matrix follow the input instructions for DATA SET 14.

IOUADV = Unit number on which the ADV package input file is read. The ADV package (Anderman and Hill, 1997, USGS Open-File Report 97-14) supports advective-transport observations.

Line 8: Data that indicate if DATA SETS 1A, 1B, 1C, and 1D are read.

I5 NRWD	I5 NZER	I5 NPNG	I5 NLOG	
1	0	0	0	LINE 8

NRWD = Number of FORTRAN units specified in the Recharge and Evapotranspiration packages using LOCAT. If NRWD > 0, DATA SET 1A is read.

NZER = Number of time steps > 0 at which head equals zero. If NZER > 0, DATA SET 1B is read.

NPNG = Number of parameters with PID=T, KV, S1, or ETM that can have negative values. This may be the case when the second kriging method discussed in Hill (1992, p. 125) is used. If NPNG > 0, DATA SET 1C is read.

NLOG = Number of parameter types for which interpolation is accomplished using log-transformed parameters. If NLOG>0, DATA SET 1D is read. NLOG must be ≤ 4.

DATA SET 1A (Omit if NRWD=0 on LINE 8)

I5 IRWD	(16I5)
30	DATA SET 1A

IRWD = NRWD (LINE 8) FORTRAN input unit numbers specified within the Recharge and Evapotranspiration package input files using LOCAT.

DATA SET 1B (Omit if NZER=0 on LINE 8)

I5 IZER	I5 IZER	(16I5)
3	4	DATA SET 1B
		(not in example)

IZER = NZER (LINE 8) time steps at which all hydraulic heads and sensitivities are set to 0.0. See item 8d in Hill (1992, p. 107).

DATA SET 1C (Omit if NPNG=0 on LINE 8)

I5 IPNG	(16I5)
3	DATA SET 1C
	(not in example)

IPNG = NPNG (LINE 8) parameter numbers (in the order parameters are listed in DATA SETS 2B) for parameters with PID=T, KV, S1, or ETM that can have negative values. This may be the case when the second kriging method discussed in Hill (1992, p. 125) is used.

DATA SET 1D (Omit if NLOG=0 on LINE 8)

I5	I5	(4I5)	
ILOG(1)	ILOG(2)....ILOG(NLOG)		
1	3		DATA SET 1D
			(not in example)

ILOG(I) = Each ILOG(I) value indicates a type of parameter which is to be interpolated using log-transformed parameters. The order in which the ILOG(I) values are listed is unimportant.

ILOG(I)=1: The parameter type is PID=T, and horizontal hydraulic conductivity for all layers is interpolated using log-transformed parameters. Contributions to the vertical leakances are calculated using the interpolated horizontal hydraulic conductivity distribution, and the first NLAY multiplication arrays are used as layer thicknesses in calculating vertical leakances and transmissivities (see DATA SET 3 instructions). To interpolate transmissivity instead of hydraulic conductivity, use ILOG(I)=-1.

ILOG(I)=2: The parameter type is PID=KV, and vertical leakance is interpolated using log-transformed parameter values.

ILOG(I)=3: The parameter type is S1, and specific storage (LAYCON=0, 2, or 3) or specific yield (LAYCON=1) is interpolated using log-transformed parameter values. The first NLAY multiplication arrays are used as layer thicknesses in calculating the storage coefficient. To interpolate the storage coefficient instead of specific storage, use ILOG(I)=-3.

ILOG(I)=4: The parameter type is S2, and specific storage (LAYCON= 2 or 3) is interpolated using log-transformed parameter values. The first NLAY multiplication arrays are used as layer thicknesses in calculating the storage coefficient. To interpolate the storage coefficient instead of specific storage, use ILOG(I)=-4.

NOTE: If it is specified in DATA SET 1D that interpolation using log-transformed parameters is to be performed for a parameter type, then LN must be greater than 0 in ALL DATA SETS 2 corresponding to that parameter type.

DATA SETS 2, 2A, 2B: Parameter Definition

PID = ANI & ANIV

Data Set 2

A4	I1	I5	I5	(11I5) [Additional lines (16I5)]
PID	LN	LAY(1)	LAY(2)	.....LAY(N2)
ANI	0	1	2	DATA SET 2
				(not in example)

PID = ANI or ANIV. For PID=ANIV, the parameter is defined as the horizontal hydraulic conductivity divided by the vertical hydraulic conductivity

LN = LN > 0: Estimate the natural log of the parameter. LN = 0: Estimate the parameter.

LAY(I) = Model-layer numbers to which this anisotropy applies.

DATA SETS 2, 2A, 2B: Parameter Definition (continued)

PID = Q, CH, KRB, KDR, GHB, & KST (Parameters defined using lists of cells)

Data Set 2

A4	I1	I5	I5	I5	(10I5) [Additional lines (16I5)]
PID	LN	NCEL	ITSON(1)	ITSOFF(1)	.....[ITSON(N) ITSOFF(N)]N=(N2-1)/2
KRB	1	18	0	15	DATA SET 2

PID = Q, CH, KRB, KDR, GHB, or KST.

LN = LN > 0: Estimate the natural log of the parameter. LN = 0: Estimate the parameter. NOTE: This option is not available for PID=Q.

|NCEL| = Number of cell locations or stream reaches that follow in DATA SET 2A.

If NCEL < 0, FACTOR of DATA SET 2A will be set to 1.0 for all listed cells in DATA SET 2A, and the model input equals the product of the parameter value specified in DATA SET 8 and SFAC of DATA SET 2A.

If NCEL > 0, the model input for each listed cell equals the parameter value (in DATA SET 8) multiplied by SFAC and FACTOR of DATA SET 2A.

ITSON(I) = At the beginning of this time step, the pumping rate or head-dependent boundary parameter is applied.

ITSOFF(I) = After the end of this time step, the pumping rate or head-dependent boundary parameter is no longer applied.

Data Set 2A, Line 1

F10.0	I5	
SFAC	IUP	
1.0	0	DATA SET 2A, LINE 1

|IUP| = The cells or reaches listed in DATA SET 2A are read from unit |IUP|. If IUP=0, it is set to the unit number for the Parameter-Estimation input file. If IUP<0, DATA SET 2A is not printed.

SFAC = See |NCEL|, above.

Data Set 2A, Lines 2 through |NCEL|+1, PID = KRB, KDR, and GHB

F10.0	F10.0	F10.0	10X	F10.0		
LAYER	ROW	COLUMN		FACTOR		
1	1	1	100	1000	90	DATA SET
1	2	1	100	1000	90	2A

Data Set 2A, Lines 2 through |NCEL|+1, PID = Q and CH

F10.0	F10.0	F10.0	F10.0	
LAYER	ROW	COLUMN	FACTOR	
1	9	10	1.0	DATA SET 2A
2	9	10	1.0	

Data Set 2A, Lines 2 through |NCEL|+1, PID = KST

15X			F5.0	F5.0		25X	F10.0			
			SEG	RCH			FACTOR			
1	2	1	1	1	0.0	100	1000.0	90	95	DS
1	2	1	1	2	0.0	100	1000.0	90	95	2A

(not in example)

DATA SETS 2, 2A, 2B: Parameter Definition (continued)

PID = RCH & ETM (Parameters defined for spatially distributed model input that apply over the top of the modeled area)

Data Set 2

A4	1X	I5	I5	I5	(10I5) [Additional lines (16I5)]
PID		IFLAG	ITSON(1)	ITSOFF(1).....	[ITSON((N2-1)/2) ITSOFF((N2-1)/2)]
RCH		1	0	15	DATA SET 2

PID = RCH or ETM.

IFLAG = IFLAG < 0: The parameter (DATA SET 8) equals the recharge or maximum evapotranspiration rate at all active cells. No DATA SET 2B.

IFLAG > 0: The parameter is a multiplicative constant and / or applies over only part of the modelled area. DATA SET 2B follows.

ITSON(I) = At the beginning of this time step, the recharge or maximum evapotranspiration rate starts.

ITSOFF(I) = At the end of this time step, the recharge or maximum evapotranspiration rate stops.

Data Set 2B

F10.0	I5	I5	I5	(13I5) [Additional lines (16I5)]
SFAC	LM	LZA	LZ(1)	LZ(LZI1)
1.	0	1	1	DATA SET 2B

SFAC = Factor by which the parameter specified in DATA SET 8 is multiplied; applies to all active cells.

LM = Multiplication array number (zero if no multiplication array).

LZA = Zone array number (zero if no zone array).

LZ(I) = Zone numbers in zone array LZA to which this RCH or ETM parameter applies. Zone numbers must be positive, non-zero integers.

See Hill (1992, p. 116-124) for a discussion of the calculation of spatially variable model input using PID=RCH and ETM. In brief, cell values for spatially distributed model inputs are calculated as the product of all of the following quantities, if they are specified for a particular PID:

Parameter value (DATA SET 8)

SFAC (DATA SET 2B)

CNSTNT (DATA SET 3)

Multiplication array entries (DATA SET 3).

The RCH and ETM arrays may also result from adding contributions from more than one parameter. In this circumstance, the contribution from each parameter is calculated as above. This additive feature allows for the use of interpolation methods such as kriging.

DATA SETS 2, 2A, 2B: Parameter Definition (continued)

PID = T, KV, S1 & S2 (Parameters defined for spatially distributed model inputs that apply to or between model layers)

Data Set 2

A4	I1	I5	(10I5) [Additional lines (16I5)]
PID	LN	LAY(1).....	.....LAY(N2)
T	1	2	DATA SET 2

PID = T, KV, S1, or S2.

LN = LN > 0: Estimate the natural log of the parameter. LN = 0: Estimate the parameter.

|LAY(I)| = A model layer number. If LAY < 0, The parameter (DATA SET 8) equals the model input at all active cells, and DATA SET 2B is not read.If LAY > 0,The parameter is a multiplicative constant and / or applies to only part of the modelled area. DATA SET 2B follows in the order in which positive LAY values occur.

Data Set 2B

For this parameter, one repetition of DATA SET 2B is needed for each LAY(I)>0 in DATA SET 2.

F10.0	I5	I5	I5	(13I5) [Additional lines (16I5)]
SFAC	LM	LZA	LZ(1)	.....LZ(LZI1)
50.	1	0		DATA SET 2C

SFAC = Factor by which the parameter specified in DATA SET 8 is multiplied; applies to all active cells.

LM = Multiplication array number (zero if no multiplication array).

LZA = Zone array number (zero if no zone array).

LZ(I) = Zone numbers in zone array LZA to which this T, KV, S1, or S2 parameter applies. Zone numbers must be positive, non-zero integers.

See Hill (1992, p. 116-124) for a discussion of the calculation of spatially variable model input using PID=T, KV, and S1. In brief, spatially distributed model inputs are calculated as the product of all of the following quantities, if they are specified for a particular PID:

Parameter value (DATA SET 8)

SFAC (DATA SET 2B)

CNSTNT (DATA SET 3)

Multiplication array entries (DATA SET 3).

The T, KV, S1, and S2 arrays may also result from adding contributions from more than one parameter. In this circumstance, the contribution from each parameter is calculated as above. This additive feature allows for the use of interpolation methods such as kriging. Additions may be made using log-transformed or untransformed values, as specified in data set 1D.

Note: If layer thicknesses are specified in DATA SET 3, these are used only in calculating contributions to vertical leakance from the parameter(s) represented by PID=T. If PID=T, and DATA SET 8 contains hydraulic conductivity, the matrices of layer thicknesses in DATA SET 3 are NOT automatically used to calculate transmissivities for confined or convertible layers. However, these matrices may be used for this purpose by setting the variable LM in DATA SET 2B to the appropriate multiplication array number of the thickness array.

DATA SETS 3 and 3A: Multiplication Arrays

Data Set 3: Multiplication arrays input by the user.

NMM (LINE 3) repetitions of DATA SET 3 are required. Omit if NMM=0. Multiplication arrays are referenced using LM of DATA SETS 2B using sequential numbers that equal 1 for the first multiplication array in DATA SET 3, 2 for the second multiplication array, and so on. If any PID = T or KV and there is more than one model layer, then the first NLAY multiplication layers must be equal to the thicknesses of all NLAY model layers.

I10	F10.0	5A4	I10	
LOCAT	CNSTNT	FMTIN	IPRN	
16	1.0	(18F3.0)	2	DATA SET 3

LOCAT = Flag indicating the location of the data to be put in the multiplication array:
LOCAT < 0 : |LOCAT| is the unit from which binary data values will be read.
LOCAT = 0 : every array element will be set to the value CNSTNT.
LOCAT > 0 : LOCAT is the unit from which data values will be read using the format FMTIN.
Note that if LOCAT = unit number of the INPUT FILE, the multiplication array will be specified in the INPUT FILE directly following the first line of DATA SET 3.

CNSTNT = A real number constant whose use depends on the value of LOCAT:
If LOCAT = 0, every element in the multiplication array is set equal to CNSTNT
If LOCAT ≠ 0, elements in the multiplication array are equal to the product of CNSTNT and the value read in on unit LOCAT.

FMTIN = The real number format of records read from unit LOCAT. Only required if LOCAT > 0. Must be in parentheses.

IPRN = Flag identifying the format in which the multiplication array is printed. Only required if LOCAT ≠ 0. Format codes for printing real arrays are listed in Hill (1992, Table A2, p. 150). If IPRN < 0, the multiplication array is not printed.

Data Set 3A: Definition of multiplication arrays to be calculated in MODFLOWP.

NMP (LINE 3) repetitions of DATA SET 3A are required. Omit if NMP=0. The multiplication arrays defined in DATA SET 3A are referenced by LM of DATA SETS 2B using sequential numbers that equal NMM+1 for the first multiplication array defined in DATA SET 3A, NMM+2 for the second multiplication array defined in DATA SET 3A, etc.

I5	I5	(5I5)	
MAN(1)	MAN(2)	....MAN(5)	
1	3		DATA SET 3A
			(not in example)

MAN(I) = Each line of DATA SET 3A contains integers MAN(I) that specify how one new multiplication array is calculated. The absolute value of MAN(I) refers to the multiplication array number of a multiplication array in DATA SET 3. The elements of the new multiplication array equal the product of the elements of multiplication arrays in DATA SET 3 referred to with positive MAN(I) values, divided by elements of multiplication arrays in DATA SET 3 referred to with negative MAN(I) values.

DATA SET 4: Zone Arrays

NZM (number of zone arrays, on LINE 3) repetitions of DATA SET 4 are required. Omit if NZM = 0. Zone array number 1 (LZ of DATA SET 2B) must be listed first, number 2 must be listed second, etc. Each zone array may include many zone numbers.

I10	I10	5A4	I10	
LOCAT	ICONST	FMTIN	IPRN	
16	1(9I8)		2	DATA SET 4

LOCAT = Flag indicating the location of the data to be put in the zone array:
LOCAT < 0 : |LOCAT| is the unit from which binary data values will be read.
LOCAT = 0 : every array element will be set to the value ICONST.
LOCAT > 0 : LOCAT is the unit from which data values will be read using the format FMTIN.
Note that if LOCAT = unit number of the INPUT FILE, the zone array will be specified in the INPUT FILE directly following the first line of DATA SET 4.

ICONST = An integer constant whose use depends on the value of LOCAT:
If LOCAT = 0, every element in the zone array is set equal to ICONST.
If LOCAT ≠ 0, elements in the zone array are equal to the product of ICONST and the value read in on unit LOCAT.

FMTIN = The integer format of records read from unit LOCAT. Only required if LOCAT > 0. Must be in parentheses.

IPRN = Flag identifying the format in which the zone array is printed. Only required if LOCAT ≠ 0. Format codes for printing integer arrays are listed below. If IPRN < 0, the zone array is not printed.

IPRN	Format	IPRN	Format	IPRN	Format
0	10I11	2	40I2	4	25I4
1	60I1	3	30I3	5	20I5

DATA SET 5: Variance Multipliers and Input Unit Numbers for Observations

F10.0	F10.0	I5	I5	F10.0	
EVH	EVF	IUH	IUF	EV	
1.	1.	0	0	1.	DATA SET 5

EVH = Input error variance multiplier for head observations (σ_h^2 of equation 22 in Hill (1992)).
EVF = Input error variance multiplier for flow observations (σ_f^2 of equation 22 in Hill (1992)).
|IUH| = Input unit number for head observations.
|IUF| = Input unit number for head-dependent boundary flow gain or loss observations.
EV = Estimated common error variance.

If IUH or IUF equal 0, its value is set to the unit number of the INPUT FILE.

If IUH (or IUF) < 0, the list of head (flow) observations is not printed in the output file.

DATA SETS 6, 6A, 6B, & 6C: Hydraulic Head Observations

Data Set 6

Repeat DATA SET 6 for each head observation location.

A4	1X	I5	I5	I5	I5	F8.0	F8.0	F8.0	F10.0	F8.0	I5	
DID		LAY	ROW	COL	TS	ROFF	COFF	TOFF	HOBS	STAT	IST	
1.0		1	3	1	-3	0.00	0.00	0.00	0.000	0.00	0	DS 6

DID = Data identifier (any 4 characters).

|LAY| = Model layer in which observation is located. If LAY < 0, the observation is multilayer, and DATA SET 6A is read. For multilayer observations, there can be a maximum of MAXM (LINE 5) layers.

ROW = Model row in which observation is located.

COL = Model column in which observation is located.

TS = Time step of observation. If TS < 0, there are observations at |TS| time steps, and DATA SETS 6B and 6C are read. DID, HOBS, and STAT of DATA SET 6 are replaced by values from DATA SET 6C.

ROFF = Row offset (See Hill, 1992, p. 21-23).

COFF = Column offset (See Hill, 1992, p. 21-23).

TOFF = Time-step offset (See Hill, 1992, p. 20).

HOBS = Head observation.

STAT = Value from which the weight for the observed head is calculated.

IST = A flag indicating what STAT is, and how the weights on the head observations are calculated (EV and EVH are read in DATA SET 5):

IST	STAT	Hydraulic Head Weight equals:
0	scaled variance	EV / (STAT x EVH)
1	scaled standard deviation	EV/ ($STAT^2$ x EVH)
2	scaled coefficient of variation	EV/ [($STATxHOBS)^2$ x EVH)]

Data Set 6A: Data for Multilayer Head Observations

For each DATA SET 6 with LAY < 0, there must be |LAY| pairs of (MLAY, PR) in DATA SET 6A.

I5	F5.0	I5	F5.0	8(I5,F5.0)	
MLAY(1)	PR(1)	MLAY(2)	PR(2)	.....[MLAY(|LAY|),PR(|LAY|)]	
1	0.5	2	0.5		DATA SET 6A
					(not in example)

MLAY(I) = Layer number.

PR(I) = Proportion of simulated hydraulic head in layer I that is used in calculating simulated multilayer head. Sum of all PR values must equal 1.0.

Data Sets 6B and 6C: Data for Transient Head Observations

Data Set 6B

I5	
ITT	
2	DATA SET 6B

Data Set 6C

A4	1X	I5	F8.0	F10.0	F10.0	F10.0	I5	
DID		TS	TOFF	HOBS	$STAT_h$	$STAT_{DD}$	IST	
1.0		0	0.00	101.804	1.0025	0.0025	0	DS 6C
1.1		1	0.00	101.775	1.0025	0.0025	0	
1.12		12	0.00	101.675	1.0025	0.0025	0	

ITT = ITT = 1: Observed hydraulic heads are used.

ITT = 2: Observed initial head and subsequent changes in head (for example, drawdown) are used. Note that the change in head is calculated by MODFLOWP from head values specified in the data set.

DID = Data identifier.

TS = Time step of the hydraulic head observation.

TOFF = Time-step offset (See Hill, 1992, p. 20).

HOBS = Head observation.

$STAT_h$ = Value from which the weight for the observed head is calculated.

$STAT_{DD}$ = Value from which the weight for the observed drawdown is calculated.

IST = A flag indicating what STAT is, and how the weights on the head and drawdown observations are calculated (See description of IST in DATA SET 6).

The first line of DATA SET 6C must be the earliest observed head at this location, and $STAT_h$ is used to calculate the weight.

DATA SETS 7, 7A, and 7B: Flow Observations

DATA SETS 7, 7A, and 7B are read from input unit IUF (DATA SET 5) and are each repeated for each of the NQ (LINE 5) cell groups that define head-dependent boundaries with observed flow gains or losses.

Data Set 7

I5 IBT	I5 NQOB	I5 NQCL	
3	3	-18	DATA SET 7

IBT = Boundary type:
IBT = 1 --> River Package IBT = 2 --> General Head Boundary Package
IBT = 3 --> Stream Package IBT = 4 --> Drain Package

NQOB = Number of times at which fluxes are observed for this group of cells

|NQCL| = Number of finite-difference cells in this group. If NQCL<0, FACTOR = 1.0 for all cells in group.

Data Set 7A

A4 DID	1X	I5 TS	F8.0 TOFF	F10.0 HOBS	F10.0 STAT	I5 IST	
SS		0	0.0	-4.4	0.40	1	DATA SET 7A
TR3		3	0.0	-4.1	0.38	1	

DID = Data identifier (any 4 characters)

IQOB = Time step at which fluxes are observed for this group of cells (0 for steady state)

TOFF = Time-step offset (See Hill, 1992, p. 20).

HOBS = Head-dependent boundary gain (-) or loss (+) observation for this group of cells.

STAT = Value from which weight of observed flux is calculated.

IST = Flag indicating what STAT is; see instructions for DATA SET 6 (EVF is used instead of EVH).

Note: read STAT and IST only if IOWTQ=0 on LINE 7.

Data Set 7B

For the Streamflow-Routing Package (IBT=3):

			15X	F5.0 SEG	F5.0 RCH	F10.0 FACTOR					
1	1	1		1	1	10.0	100	1000.0	90	95	DS
1	2	1		1	2	0.0	100	1000.0	90	95	7B

(not in example)

(In the MODFLOWP input instructions, SEG and RCH are called QCLS(1) and QCLS(2).)

For the River, GHB, and Drain Packages (IBT=1, 2, and 4):

F10.0 LAYER	F10.0 ROW	F10.0 COLUMN	F10.0 FACTOR			
1	1	1	100	1000	90	DATA SET
1	2	1	100	1000	90	7B

(In the MODFLOWP input instructions, LAYER, ROW, and COLUMN are called QCLS(1), QCLS(2), and QCLS(3).)

FACTOR = portion of the simulated gain or loss in this cell that is included in the total simulated gain or loss for this group (see Hill, 1992, page 26).

DATA SET 8: Initial Parameter Values

F13.0 B(1)	F13.0 B(2)	F13.0 B(3)	F13.0 B(4)	F13.0 B(5)	F13.0 B(6)	
-1.1	1.3E-3	3.00E-4	1.2E-3	1.E-7	2.E-4	DS8

F13.0 B(7)	F13.0 B(8)	F13.0 B(9)	(6F13.0) B(NP)
4.0E-5	2.E-8	1.0E-8	DATA SET 8, 2ND LINE

B(I) = Initial parameter value. Listed in the order in which the parameters are defined in DATA SET 2.

Parameter values specified in this data set replace model-input values read from the input files of MODFLOW packages. Do not enter the natural log of parameters in DATA SET 8, even if LN > 0 in DATA SET 2. Log transformation is done by MODFLOWP.

DATA SET 8A: Maximum Reasonable Parameter Values

F13.0 BMAX(1)	F13.0 BMAX(2)	F13.0 BMAX(3)	F13.0 BMAX(4)	F13.0 BMAX(5)	F13.0 BMAX(6)	
-5.0	1.0E-3	1.00E-4	1.0E-2	5.0E-7	1.0E-3	DS8A

F13.0 BMAX(7)	F13.0 BMAX(8)	F13.0 BMAX(9)	(6F13.0) B(NP)
1.0E-3	2.6E-8	2.6E-8	DATA SET 8A, 2ND LINE

BMAX(I) = Maximum reasonable value for parameter B(I). BMAX(I) DOES NOT RESTRICT THE ESTIMATED PARAMETER VALUE. It is printed in the MODFLOWP output to facilitate comparison with the estimated value.

DATA SET 8B: Minimum Reasonable Parameter Values

F13.0 BMIN(1)	F13.0 BMIN(2)	F13.0 BMIN(3)	F13.0 BMIN(4)	F13.0 BMIN(5)	F13.0 BMIN(6)	
0.0	1.0E-4	1.00E-5	1.0E-3	5.0E-8	1.0E-4	DS8B

F13.0 BMIN(7)	F13.0 BMIN(8)	F13.0 BMIN(9)	(6F13.0) B(NP)
1.0E-5	2.6E-9	2.6E-9	DATA SET 8B, 2ND LINE

BMIN(I) = Minimum reasonable value for parameter B(I). BMIN(I) DOES NOT RESTRICT THE ESTIMATED PARAMETER VALUE. It is printed in the MODFLOWP output to facilitate comparison with the estimated value.

DATA SET 9: Parameter Group Numbers

I13 IWPG(1)	I13 IWPG(2)	I13 IWPG(3)	I13 IWPG(4)	I13 IWPG(5)	I13 IWPG(6)	
3	4	5	6	3	4	DS9

I13 IWPG(7)	I13 IWPG(8)	I13 IWPG(9)	(6I13) ....IWPG(NP)
7	7	1	DATA SET 9, 2ND LINE

IWPG(I) = Parameter group number. IWPG(1) is the group number of the first parameter defined in the first repetition of DATA SET 2, IWPG(2) is the group number of the second parameter defined in a repetition of DATA SET 2, etc.

IWPG(I) > 0 --> Residuals related to prior information are printed by group.

IWPG(I) < 0 --> Parameter values are FIXED -- values from DATA SET 8 replace model-input values read from other MODFLOW packages, but are not estimated by regression.

All positive group numbers must precede any negative group numbers.

DATA SET 10: Weights of prior estimates (read only if IPAR > 0)

F13.0 STATP(1)	F13.0 STATP(2)	F13.0 STATP(3)	F13.0 STATP(4)	F13.0 STATP(5)	F13.0 STATP(6)	
.1	1.0E-4	4.00E-5	1.0E-4	0.	0.	DS10

F13.0 STATP(7)	F13.0 STATP(8)	F13.0 STATP(9)	(6F13.0) ....STATP(NP)
0.	1.E-9	1.5E-9	DATA SET 10, 2ND LINE

STATP(I) = Flag identifying which parameters listed in DATA SET 8 are to be used as prior information, and value used to calculate the weight of the prior estimate:

If STATP(I) = 0.0, there is no prior estimate of parameter B(I) used in the regression.

If STATP(I) $\neq$ 0.0, B(I) is used as the prior estimate of the parameter, and the value of ISP in DATA SET 11 indicates what STATP is, and how the weight for this prior estimate is calculated.

If LN(I) $\neq$ 0 (DATA SET 2), STATP(I) describes the probability distribution function of the natural log of the parameter. The prior information is not used in the regression if IPRIOR=0 (DATA SET 13A).

DATA SET 10.1: Parameters with a full weight matrix (read only if IPR>0)

I13 NIPR(1)	I13 NIPR(2)	I13 NIPR(3)	I13 NIPR(4)	(6I13) ....NIPR(IPR)
3	4	5	6	DATA SET 10.1

(not in example)

NIPR(I) = Parameter number of one of the IPR prior parameter values for which a full weight matrix is specified. The variance-covariance matrix for the IPR parameters is read in DATA SET 10.3.

DATA SET 10.2: Prior parameter estimates for parameters with a full weight matrix (read only if IPR>0)

F13.0 BPR(1)	F13.0 BPR(2)	F13.0 BPR(3)	F13.0 BPR(4)	(6F13.0) .....BPR(IPR)
1.0e-5	5.0e-3	2.0e-7	1.0e-2	DATA SET 10.2

(not in example)

BPR(I) = Prior parameter estimate for one of the IPR prior parameter values for which a full weight matrix is specified.

DATA SET 10.3: Full weight matrix on prior parameter estimates (read only if IPR > 0)

IPR (LINE 5) repetitions of DATA SET 10.3 are required.

F13.0 WPF(1,1)	F13.0 WPF(1,2)	F13.0 WPF(1,3)	F13.0 WPF(1,4)	(6F13.0) .....WPF(1,IPR)
0.02	0.5	0.1	0.01	

F13.0 WPF(2,1)	F13.0 WPF(2,2)	F13.0 WPF(2,3)	F13.0 WPF(2,4)	(6F13.0) .....WPF(2,IPR)
0.5	0.07	0.3	0.3	

.
.
.

F13.0 WPF(IPR,1)	F13.0 WPF(IPR,2)	F13.0 WPF(IPR,3)	F13.0 WPF(IPR,4)	(6F13.0) .....WPF(IPR,IPR)
0.01	0.65	0.02	0.09	

(not in example)

WPF(I,J) = If I ≠ J, WPF(I,J) is the covariance between parameters I and J.
If I = J, WPF(I,I) is the variance of parameter I.
Thus, the set of lines that forms DATA SET 10.3 contains the entire variance-covariance matrix on the prior parameter estimates. This matrix is symmetrical (WPF(I,J)=WPF(J,I)), but the entire matrix (upper and lower parts) must be entered in DATA SET 10.3.

DATA SET 11: Flag for weights of prior estimates (read only if IPAR > 0)

I10 ISP	
1	DATA SET 11

ISP = Flag identifying how the weights on the prior estimates are to be calculated from STATP of DATA SETS 10 and 12:

ISP	STATP	Weight on Prior equals:
0	variance	EV / [(STATP(I))]
1	standard deviation	EV / [$(STATP(I))^2$]
2	coefficient of variation	EV / [$(STATP(I) \times B(I))^2$]

DATA SET 12: Data for specifying equations of prior information (read only if IPAR > 0)

MPR (LINE 5) repetitions of DATA SET 12 are required.

F13.0 PRM(1)	F13.0....(6F13.0) PRM(2)...PRM(NP)	F13.0 PRE	F13.0 STATP	
0.3	0.0	0.0	0.0	DATA SET 12
				(not in example)

PRM(I) = The coefficient of the Ith parameter. If PRM(I) = 0.0, the Ith parameter is not included.

PRE = The prior estimate.

STATP = The value from which the weight is calculated. ISP of DATA SET 11 identifies how the weight is to be calculated.

The prior information is not used in the regression if IPRIOR=0 (DATA SET 13)

DATA SETS 13A, 13B, 13C, and 13D: Data that affect how estimation is done and what is printed (read only if IPAR > 0)

Data Set 13A: Commonly changed variables.

F5.0 DMAX	F5.0 TOL	I5 ITMXP	I5 IPRIOR	
2.0	.01	15	0	DATA SET 13A

DMAX = Maximum fractional change for parameter values in one iteration.

TOL = Parameter estimation closure criterion.

ITMXP = Maximum number of parameter estimation iterations.

IPRIOR = If IPRIOR=0, prior information from DATA SETS 10 and 12 is disregarded.

Data Set 13B: Variables that control output from MODFLOWP.

I5 IOUR	I5 IPRC	I5 IPRINT	I5 KPRINT	I5 LPRINT	
0	12	0	0	0	DATA SET 13B

IOUR = Output unit for unformatted data to be used by the program RESANP.

IPRC = Format code for printing of variance-covariance and correlation matrices. See Hill (1992, Table A2, p. 150).

IPRINT = If IPRINT>0, various estimation statistics are printed each iteration; if IPRINT=0, these statistics printed only at the first and last iterations.

KPRINT = If KPRINT=1, and estimation converges, head arrays calculated for the final parameter values are printed and saved based on values in the Output Control file. If KPRINT=0, arrays are not printed or saved. The saved arrays can be used in programs such as MODPATH (Pollack, 1989).

LPRINT = If LPRINT>0, and estimation converges, eigenvalues and eigenvectors are printed.

Data Set 13C: Variables that control calculations performed for parameter estimation.

F5.0 CSA	F5.0 FCONV	I5 LASTX	I5 NFIT	F5.0 SOSC	F5.0 SOSR	
0.08	0.0	0	0	0.0	0.0	DATA SET 13C

CSA = Search direction adjustment parameter used in Marquardt procedure. Usually equals 0.08.

FCONV = If FCONV>0, coarser solver convergence criteria are used for early parameter estimation iterations. Usually equals 0.0.

LASTX = Usually LASTX=0. A non-zero value may produce slightly more accurate parameter variances and covariances when ISN<0, and is needed to produce parameter variances and covariances when ISN>0. See Hill (1992, p. 108-109). Usually equals 0.

NFIT = Number of Fletcher-Reeves (ISN=2) or Gauss-Newton (ISN<0; NOPT=1) iterations. See Hill (1992, p. 150). Usually equals 0.

SOSC = The second convergence criterion discussed in Hill (1992, p. 81). SOSCx100 is the user-defined percentage. Usually equals 0.0.

SOSR = A criteria for using R of equation (51) in equation (50a) (Hill, 1992). R is used if the percentage change in the sum of squared weighted residuals does not exceed SOSR x100 in two parameter estimation iterations. Usually equals 0.0.

Data Set 13D: Variable FSTAT

F10.0 FSTAT	
2.76	DATA SET 13D

FSTAT = F-distribution value required to calculate parameter values for the modified Beale's measure.

DATA SET 14: Data for conjugate direction method
(read only if IPAR > 0 and ISN > 0)

F13.0 SCL(1)	F13.0 SCL(2)	F13.0 SCL(3)	F13.0 SCL(4)	F13.0 SCL(5)	F13.0 SCL(6)
-1.1	1.3E-3	3.00E-4	1.2E-3	1.E-7	2.E-4 DS14

F13.0 SCL(7)	F13.0 SCL(8)	F13.0 SCL(9)	(6F13.0) SCL(NP)
4.0E-5	2.E-8	1.0E-8	DATA SET 14, 2ND LINE (not in example)

SCL(I) = Factors used to scale parameters for conjugate-direction methods. Generally, approximately equal to B(I).

Format for full weight matrix on head-dependent flow observations
(read on unit IOWTQ of LINE 7, if IOWTQ>0)

The first line contains the input and output formats of the full weight matrix:

A20	I5	
FMTIN	IPRN	
(5F10.0)	2	line 1 of unit IOWTQ

FMTIN = The real number format of each line of the full weight matrix. Must be in parentheses.

IPRN = Flag identifying the format in which the full weight matrix is printed. These format codes are listed in Hill (1992, Table A2, p. 150). If IPRN < 0, the full weight matrix is not printed.

Lines 2 through NQT+1 contain the full weight matrix (NQT is read on LINE 5 of the Parameter-Estimation Package input file):

				line has format given by FMTIN
WTQ(1,1)	WTQ(1,2)	WTQ(1,3)	WTQ(1,4)	.....WTQ(1,NQT)
4.52	1.3	1.9	0.6	line 2 of unit IOWTQ

				line has format given by FMTIN
WTQ(2,1)	WTQ(2,2)	WTQ(2,3)	WTQ(2,4)	.....WTQ(2,NQT)
1.3	5.3	1.6	0.2	line 3 of unit IOWTQ

.
.
.

				line has format given by FMTIN
WTQ(NQT,1)	WTQ(NQT,2)	WTQ(NQT,3)	WTQ(NQT,4)	.....WTQ(NQT,NQT)
0.8	1.2	1.4	0.7	line NQT+1 of unit IOWTQ
				(not in example)

WTQ(I,J) = If I ≠ J, WTQ(I,J) is the covariance between head-dependent flow observations I and J.
If I = J, WTQ(I,I) is the variance of flow observation I.
Note that the full weight matrix is symmetrical (WTQ(I,J)=WTQ(J,I)), but the entire matrix (upper and lower parts) must be entered.

Modified Parameter-Estimation Package Input File from Test Case 1 of Hill (1992, Appendix A)

```
TWO-LAYER EXAMPLE - TRANSIENT                                        LINE 1
Modified Test Case 1 of Hill (1992, Appendix A)                      LINE 2
    9    5   56    4    2    1    0    1                             LINE 3
    2    1    1                                                      LINE 4
   32    0    0    1   18    3    0    0                             LINE 5
    1   -1    1    0    0                                            LINE 6
   40   33    0    0    0    0    0    0    0    0    0    0    0 LINE 7
    1    0    0    0                                                 LINE 8
   30                                                                DATA SET 1A
Q   0   -2    1   15                                                 DATA SET 2
         1         9        10       1.0                             DATA SET 2A
         2         9        10       1.0
S1  1   -1                                                           DATA SET 2
T   1    1                                                           DATA SET 2
       50.                                                           DATA SET 2B
KRB 1   18    0   15                                                 DATA SET 2
       1.0    0                                                      DATA SET 2A, LINE 1
         1         1          1       100     1000.        90        DATA SET 2A
         1         2          1       100     1000.        90
         1         3          1       100     1000.        90
         1         4          1       100     1000.        90
         1         5          1       100     1000.        90
         1         6          1       100     1000.        90
         1         7          1       100     1000.        90
         1         8          1       100     1000.        90
         1         9          1       100     1000.        90
         1        10          1       100     1000.        90
         1        11          1       100     1000.        90
         1        12          1       100     1000.        90
         1        13          1       100     1000.        90
         1        14          1       100     1000.        90
         1        15          1       100     1000.        90
         1        16          1       100     1000.        90
         1        17          1       100     1000.        90
         1        18          1       100     1000.        90
KV      1                                                            DATA SET 2
        .1                                                           DATA SET 2B
S1  1   -2                                                           DATA SET 2
T   1    2    0                                                      DATA SET 2
       50.    1                                                      DATA SET 2B
RCH      1    0   15                                                 DATA SET 2
        1.    0    1    1                                            DATA SET 2B
RCH      1    0   15                                                 DATA SET 2
        1.    0    1    2                                            DATA SET 2B
         0        50.                                                DATA SET 3
         0        50.                                                DATA SET 3
        16         1.(18F3.0)            2                           DATA SET 3
 1 1 2 2 3 3 4 4 5 5 6 6 7 7 8 8 9 9
 1 1 2 2 3 3 4 4 5 5 6 6 7 7 8 8 9 9
 1 1 2 2 3 3 4 4 5 5 6 6 7 7 8 8 9 9
 1 1 2 2 3 3 4 4 5 5 6 6 7 7 8 8 9 9
 1 1 2 2 3 3 4 4 5 5 6 6 7 7 8 8 9 9
 1 1 2 2 3 3 4 4 5 5 6 6 7 7 8 8 9 9
 1 1 2 2 3 3 4 4 5 5 6 6 7 7 8 8 9 9
 1 1 2 2 3 3 4 4 5 5 6 6 7 7 8 8 9 9
 1 1 2 2 3 3 4 4 5 5 6 6 7 7 8 8 9 9
 1 1 2 2 3 3 4 4 5 5 6 6 7 7 8 8 9 9
 1 1 2 2 3 3 4 4 5 5 6 6 7 7 8 8 9 9
 1 1 2 2 3 3 4 4 5 5 6 6 7 7 8 8 9 9
 1 1 2 2 3 3 4 4 5 5 6 6 7 7 8 8 9 9
 1 1 2 2 3 3 4 4 5 5 6 6 7 7 8 8 9 9
```

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 1 1 2 2 3 3 4 4 5 5 6 6 7 7 8 8 9 9
 1 1 2 2 3 3 4 4 5 5 6 6 7 7 8 8 9 9
 1 1 2 2 3 3 4 4 5 5 6 6 7 7 8 8 9 9
 1 1 2 2 3 3 4 4 5 5 6 6 7 7 8 8 9 9
      16         1(9I8)           2                                     DATA SET 4
       1       1       1       1       1       1       1       1       1
       2       2       2       2       2       2       2       2       2
       1       1       1       1       1       1       1       1       1
       2       2       2       2       2       2       2       2       2
       1       1       1       1       1       1       1       1       1
       2       2       2       2       2       2       2       2       2
       1       1       1       1       1       1       1       1       1
       2       2       2       2       2       2       2       2       2
       1       1       1       1       1       1       1       1       1
       2       2       2       2       2       2       2       2       2
       1       1       1       1       1       1       1       1       1
       2       2       2       2       2       2       2       2       2
       1       1       1       1       1       1       1       1       1
       2       2       2       2       2       2       2       2       2
       1       1       1       1       1       1       1       1       1
       2       2       2       2       2       2       2       2       2
       1       1       1       1       1       1       1       1       1
       2       2       2       2       2       2       2       2       2
       1       1       1       1       1       1       1       1       1
       2       2       2       2       2       2       2       2       2
       1       1       1       1       1       1       1       1       1
       2       2       2       2       2       2       2       2       2
       1       1       1       1       1       1       1       1       1
       2       2       2       2       2       2       2       2       2
       1       1       1       1       1       1       1       1       1
       2       2       2       2       2       2       2       2       2
       1       1       1       1       1       1       1       1       1
       2       2       2       2       2       2       2       2       2
       1       1       1       1       1       1       1       1       1
       2       2       2       2       2       2       2       2       2
       1       1       1       1       1       1       1       1       1
       2       2       2       2       2       2       2       2       2
       1       1       1       1       1       1       1       1       1
       2       2       2       2       2       2       2       2       2
       1       1       1       1       1       1       1       1       1
       2       2       2       2       2       2       2       2       2
       1.0        1.0    0    0       1.0                                   DATA SET 5
1.0        1    3    1   -3    0.00    0.00    0.00     0.000    0.00    0 DATA SET 6
    2                                                                    DATA SET 6B
1.0        0    0.00   101.804    1.0025    0.0025    0                  DATA SET 6C
1.1        1    0.00   101.775    1.0025    0.0025    0
1.12      12    0.00   101.675    1.0025    0.0025    0
2.0        1    4    4   -5    0.00    0.00    0.00     0.000    0.00    0 DATA SET 6
    2                                                                    DATA SET 6B
2.0        0    0.00   128.117    1.0025    0.0025    0                  DATA SET 6C
2.1        1    0.00   128.076    1.0025    0.0025    0
2.2        2    0.00   127.560    1.0025    0.0025    0
2.8        8    0.00   116.586    1.0025    0.0025    0
2.12      12    0.00   113.933    1.0025    0.0025    0
3.0        1   10    9   -3    0.00    0.00    0.00     0.000    0.00    0 DATA SET 6
    2                                                                    DATA SET 6B
3.0        0    0.00   156.678    1.0025    0.0025    0                  DATA SET 6C
3.1        1    0.00   152.297    1.0025    0.0025    0
3.12      12    0.00   114.138    1.0025    0.0025    0
4.0        1   13    4   -3    0.00    0.00    0.00     0.000    0.00    0 DATA SET 6
    2                                                                    DATA SET 6B
4.0        0    0.00   124.893    1.0025    0.0025    0                  DATA SET 6C
4.1        1    0.00   124.826    1.0025    0.0025    0
4.12      12    0.00   110.589    1.0025    0.0025    0
```

```
5.0      1   14    6   -3    0.00    0.00    0.00     0.000    0.00    0 DATA SET 6
    2                                                                     DATA SET 6B
5.0      0    0.00   140.961    1.0025    0.0025    0                    DATA SET 6C
5.1      1    0.00   140.901    1.0025    0.0025    0
5.12    12    0.00   119.285    1.0025    0.0025    0
6.0      2    4    4   -3    0.00    0.00    0.00     0.000    0.00    0 DATA SET 6
    2                                                                     DATA SET 6B
6.0      0    0.00   126.537    1.0025    0.0025    0                    DATA SET 6C
6.1      1    0.00   126.542    1.0025    0.0025    0
6.12    12    0.00   112.172    1.0025    0.0025    0
7.0      2   10    1   -3    0.00    0.00    0.00     0.000    0.00    0 DATA SET 6
    2                                                                     DATA SET 6B
7.0      0    0.00   101.112    1.0025    0.0025    0                    DATA SET 6C
7.1      1    0.00   101.160    1.0025    0.0025    0
7.12    12    0.00   100.544    1.0025    0.0025    0
8.0      2   10    9   -3    0.00    0.00    0.00     0.000    0.00    0 DATA SET 6
    2                                                                     DATA SET 6B
8.0      0    0.00   158.135    1.0025    0.0025    0                    DATA SET 6C
8.1      1    0.00   152.602    1.0025    0.0025    0
8.12    12    0.00   114.918    1.0025    0.0025    0
9.0      2   10   18   -3    0.00    0.00    0.00     0.000    0.00    0 DATA SET 6
    2                                                                     DATA SET 6B
9.0      0    0.00   176.374    1.0025    0.0025    0                    DATA SET 6C
9.1      1    0.00   176.373    1.0025    0.0025    0
9.12    12    0.00   138.132    1.0025    0.0025    0
0.0      2   18    6   -3    0.00    0.00    0.00     0.000    0.00    0 DATA SET 6
    2                                                                     DATA SET 6B
0.0      0    0.00   142.020    1.0025    0.0025    0                    DATA SET 6C
0.1      1    0.00   142.007    1.0025    0.0025    0
0.12    12    0.00   122.099    1.0025    0.0025    0
    3    3 -18                                                          DATA SET 7
SS       0     0.0      -4.4   .400000    1                           DATA SET 7A
TR3      3     0.0      -4.1   .380000    1                           DATA SET 7A
TR12    12     0.0      -2.2   .210000    1                           DATA SET 7A
         1         1          1       100     1000.        90          DATA SET 7B
         1         2          1       100     1000.        90
         1         3          1       100     1000.        90
         1         4          1       100     1000.        90
         1         5          1       100     1000.        90
         1         6          1       100     1000.        90
         1         7          1       100     1000.        90
         1         8          1       100     1000.        90
         1         9          1       100     1000.        90
         1        10          1       100     1000.        90
         1        11          1       100     1000.        90
         1        12          1       100     1000.        90
         1        13          1       100     1000.        90
         1        14          1       100     1000.        90
         1        15          1       100     1000.        90
         1        16          1       100     1000.        90
         1        17          1       100     1000.        90
         1        18          1       100     1000.        90
       -1.1       1.3E-3      3.00E-4       1.2E-3        1.E-7        2.E-4  DS 8
     4.0E-5        2.E-8       1.0E-8
       -5.0       1.0E-3      1.00E-4       1.0E-2        5.E-7        1.E-3  DS 8A
     1.0E-3       2.6E-8       2.6E-8
        0.0       1.0E-4      1.00E-5       1.0E-3        5.E-8        1.E-4  DS 8B
     1.0E-5       2.6E-9       2.6E-9
          3            4           5            6            3            4  DS 9
          7            7           1
         .1       1.0E-4      4.00E-5       1.0E-4           0.           0.  DS 10
         0.        1.E-9       1.5E-9
       1                                                                  DATA SET 11
  2.0  .01   15    0                                                      DATA SET 13A
```

```
   0   12    0    0    0                                        DATA SET 13B
0.08  0.0    0    0  0.0  0.0                                   DATA SET 13C
     2.76                                                       DATA SET 13D
```