**A28. UNCERTAINTY ANALYSIS INPUT REQUIREMENTS**

A complete uncertainty analysis requires execution of three related phases, the setup phase, a simulation phase consisting of several runs, and the post processing phase.

Because of the large number of files involved in the uncertainty analysis, specific suffixes on file names are required. Also to eliminate modification of the input file used during the simulation runs command line option is used to indicate the uncertainty phase and the run number during the simulation phase runs.

The setup phase generates the uncertainty weight information needed for each run and the post processing phase. The setup phase generates the total number of simulation runs needed based on either a user specified quantity, a value determined from the Wilks’ formula with a provision for sparse. The setup information is written on disk files, one for each simulation run, and another one for the post processing. The setup phase requires the standard input file that will also be used in each simulation run and information to determine the number of runs using information entered on card 29000000. Cards 290XXXXX allow the user to modify the generation of weight for correlations that are built into the code. Cards 291XXXXX allow the user to specify weights for user supplied input data. The command line for executing the setup phase is

relap5o.exe -i mylbreak.is -uncrun setup (MOD4.x)

relap5o.exe -i mylbreak.is -U setup (MOD3.x)

The file name, "mylbreak" in the example above, has to be the same name in all phases. Same name is used for the input, output, restart plot and weight files. The command line will specify the file name as the input file but the other file names will be generated internally and are not entered on the command line. The suffix "is" is the required suffix for the input file. The output file will be mylbreak.os, the restart plot file will be mylbreak.rs, and the weight files will be mylbreakNNNN.w. The number of weight files, Nw, will be equal the number of uncertainty runs entered or determined during this phase and NNNN will range from 0001 through Nw.

The simulation phase requires a base run in which the simulation is done as there were no uncertainty option available, and the set of uncertainty runs which have uncertainty input and source modifications. The simulation phase reads a file generated by the setup phase for each run and writes information to be used in the post processing in the plot records of the restart plot file.

The input data used for the simulation phase should be the same for the base run and each simulation run and is also the same used during the setup run. The command line for executing the simulation phase is

relap5o.exe -i mylbreak.i -uncrun n (MOD4.x)

relap5o.exe -i mylbreak.i -U n (MOD3.x)

The suffix "i" is the required suffix for the input file. The number n is 0 for the base case and is the run number for the uncertainty runs, and this number written as four digits with leading zeros will be appended to the name of the output and restart plot files, mylbreaknnnn.o mylbreaknnnn.r. The weight file to be used in the uncertainty runs will be mylbreakNNNN.w.

The post processing phase reads the restart plot files written during the base and the uncertainty runs and generates the rank matrices (values sorted according its rank). The rank matrices are written to disk for each parameter for which bounds are to be obtained. These parameters are defined in cards 2080XXXX. It is the user responsibility to ensure that the desired parameters are placed on the restart plot files during the simulation runs. Cards 292XXXXX are required to indicate the simulation runs to be included in the post processing phase. The command line for executing the post processing phase is

relap5o.exe -i mylbreak.ip -uncrun postpr (MOD4.x)

relap5o.exe -i mylbreak.ip -U postpr (MOD3.x)

The post processing phase will generate a rank matrix file for each requested parameter. Each matrix is written to disk with the file name mylbreakMMMM.m, where MMMM ranges from 0001 to the number of requested parameters. A graph containing the time history of the base result, the upper and lower and the difference between the bounds will be generated for each requested parameter. The output file will be mylbreak.op.

Cards used for the setup, simulation, post-processing phases of the uncertainty analysis are described here.

**A28.1 Card 29000000, Select Setup Run**

This card is required for the setup run, which must precede any simulation run using RELAP5-SCDAP uncertainty mode. The entire input deck is required in a setup run.

* W1(I) Beginning run number of uncertainty runs.
* W2(I) End run number of uncertainty runs.

Entries in W1 and W2 allow the specification of the runs to be done entirely from the Wilks’ formulation, or entirely by user input, or a combination of Wilks’ formulation and user input. Also the entries allow the user to run a subsequent setup run to increase the total number of runs.

If zeros are entered in both words, Wilks’ formula will be used to determine the number of uncertainty runs and weight files are generated from run number one up to the computed limit. If two positive non zeros are entered, with W2 being larger than W1, weight files are generated for the specified range. If W1 is a positive non zero and W2 is zero, weight files are generated from number entered in W1 to the number computed using Wilks’ formula.

The maximum run number is limited to 9999.

* W3(R) Confidence level of the one-sided tolerance limits. Quantity must be greater than zero and less than one.
* W4(R) Percentile of population below the one-sided tolerance limit.Quantity must be greater than zero and less than one.
* W5(I) Order of Wilks’ formula application.

Even if the number of runs is specified in W1 as a specific value the Wilks’ formula is still evaluated and the information is used to build the uncertainty bounds in the post processing phase.

The next four words are optional.

* W6(I)Number of uncertainty runs to be added to the number computed by Wilks’ formula. Quantity must be greater than or equal to zero.
* W7(I) Minimum number of uncertainty runs.
* W8(I) Maximum number of uncertainty runs. This word must be entered if W6 is entered.
* W9(I) Initial seed to initialize the random sampling. If this word is not entered, the iniital seed is 298341. This word if entered is used as the initial seed. This quantity is listed in the output file during input process of the setup information. At the end of setup processing, the next seed that would have been used is listed in the output file. It is suggested that if an additional setup run is needed to generate weight files for more uncertainty runs, this input quantity be set to the next seed listed in the prior setup run.

**A28.2 Cards 29000001 - 29001000, User Modification of Uncertainty Distribution Information Defined in Source Code**

The next words define the probability distribution function associated to the source uncertainty coefficient entered in W1.

* W1-W2(A) Alphanumeric definition of the source uncertainty coefficient. This must be entered as one alphanumeric entry of at least nine characters. Entry of at least nine characters is processed within the code as two alphanumeric words.
* W3(A) Alphanumeric definition of the distribution type. Three types of distribution are allowed. If ND is entered, the normal distribution will be used for the random sampling process. If UD is entered, the uniform distribution will be used for the random sampling process. If TD, the trapezoidal distribution will be used for the random sampling process.

The next four words are the characteristic parameters defining the distribution type entered in W3.

* W4(R) If definition entered in W3 is ND, the required quantity is the mean. If definition entered in W3 is UD, the required quantity is the minimum value. If definition entered in W3 is TD, the required quantity is the lower left limit.
* W5(R) If definition entered in W3 is ND, the required quantity is the standard deviation. If definition entered in W3 is UD, the required quantity is the maximum value. If definition entered in W3 is TD, the required quantity is the upper left limit.
* W6(R) If definition entered in W3 is TD, the required quantity is the upper right limit. In other cases enter 0.0.
* W7(R) If definition entered in W3 is TD, the required quantity is the lower right limit. In other cases enter 0.0.
* W8(R) Weight related number. If -1.0 is entered, a weight will be computed according to W3 - W7 entered information. If a positive non-zero quantity is entered, it will be used as the weight for all uncertainty code runs.
* W9T (R) Temperature. Used only in gap thermal conductivity (See “Available source correlation coefficients”). Enter zero for other source quantities.

**A28.2.1 Available source correlation coefficients:**

FRV.XXX.HYY: Interphase heat transfer (See Table 12, “Interphase heat transfer coefficients”):

* FRV identifies the interphase heat transfer coefficients.
* XXX identifies the flow regime (See Vol.II, Table 2.1-1 Flow regime Letters and numbers)
* HYY: identifies the specific coefficient:
* HIF : liquid side interfacial heat transfer coefficient per unit volume.
* HIG: vapor side interfacial heat transfer coefficient per unit volume.
* HGF: direct heating heat transfer coefficient per unit volume.

**Table 12: Interphase heat transfer coefficients**

|  |  |  |
| --- | --- | --- |
| FRV.CTB.HIF | FRV.CTB.HIG | FRV.CTB.HGF |
| FRV.CTT.HIF | FRV.CTT.HIG | FRV.CTT.HGF |
| FRV.CTM.HIF | FRV.CTM.HIG | FRV.CTM.HGF |
| FRV.BBY.HIF | FRV.BBY.HIG | FRV.BBY.HGF |
| FRV.SLG.HIF | FRV.SLG.HIG | FRV.SLG.HGF |
| FRV.ANM.HIF | FRV.ANM.HIG | FRV.ANM.HGF |
| FRV.MPR.HIF | FRV.MPR.HIG | FRV.MPR.HGF |
| FRV.IAN.HIF | FRV.IAN.HIG | FRV.IAN.HGF |
| FRV.ISL.HIF | FRV.ISL.HIG | FRV.ISL.HGF |
| FRV.MST.HIF | FRV.MST.HIG | FRV.MST.HGF |
| FRV.MPO.HIF | FRV.MPO.HIG | FRV.MPO.HGF |
| FRV.HST.HIF | FRV.HST.HIG | FRV.HST.HGF |
| FRV.VST.HIF | FRV.VST.HIG | FRV.VST.HGF |
| FRV.LEV.HIF | FRV.LEV.HIG | FRV.LEV.HGF |
| FRV.JET.HIF | FRV.JET.HIG | FRV.JET.HGF |
| FRV.MWY.HIF | FRV.MWY.HIG | FRV.MWY.HGF |
| FRV.MWA.HIF | FRV.MWA.HIG | FRV.MWA.HGF |
| FRV.MAM.HIF | FRV.MAM.HIG | FRV.MAM.HGF |
| FRV.MMS.HIF | FRV.MMS.HIG | FRV.MMS.HGF |
| FRV.MWS.HIF | FRV.MWS.HIG | FRV.MWS.HGF |
| FRV.MWP.HIF | FRV.MWP.HIG | FRV.MWP.HGF |
| FRV.MPL.HIF | FRV.MPL.HIG | FRV.MPL.HGF |
| FRV.MPS.HIF | FRV.MPS.HIG | FRV.MPS.HGF |
| FRV.MSL.HIF | FRV.MSL.HIG | FRV.MSL.HGF |
| FRV.MPB.HIF | FRV.MPB.HIG | FRV.MPB.HGF |
| FRV.MBB.HIF | FRV.MBB.HIG | FRV.MBB.HGF |

HTC.NN.GGG: Heat transfer coefficients (See Table 13, “Heat transfer coefficients”)

* HTC identifies the heat transfer coefficients.
* NN: mode heat transfer number (See Vol.IV, page 111)
* GGG: hydraulic geometry surrounding the surface number (See CARDS 1CCCGXNN, HEAT STRUCTURE INPUT):
* 101 : default for geometry numbers 1, 100, 101, 103-109, 114.
* 110: default for geometry numbers 110, 112.
* 111: default for geometry numbers 111, 113.
* 130: default for geometry numbers 121-133,130.
* 134: default for geometry numbers 134-137.

**Table 13: Heat transfer coefficients**

|  |  |  |  |
| --- | --- | --- | --- |
| HTC.00.101 | HTC.01.101 | HTC.02.101 | HTC.03.101 |
| HTC.04.101 | HTC.05.101 | HTC.06.101 | HTC.07.101 |
| HTC.08.101 | HTC.09.101 | HTC.10.101 | HTC.11.101 |
| HTC.00.110 | HTC.01.110 | HTC.02.110 | HTC.03.110 |
| HTC.04.110 | HTC.05.110 | HTC.06.110 | HTC.07.110 |
| HTC.08.110 | HTC.09.110 | HTC.10.110 | HTC.11.110 |
| HTC.00.111 | HTC.01.111 | HTC.02.111 | HTC.03.111 |
| HTC.04.111 | HTC.05.111 | HTC.06.111 | HTC.07.111 |
| HTC.08.111 | HTC.09.111 | HTC.10.111 | HTC.11.111 |
| HTC.00.130 | HTC.01.130 | HTC.02.130 | HTC.03.130 |
| HTC.04.130 | HTC.05.130 | HTC.06.130 | HTC.07.130 |
| HTC.08.130 | HTC.09.130 | HTC.10.130 | HTC.11.130 |
| HTC.00.134 | HTC.01.134 | HTC.02.134 | HTC.03.134 |
| HTC.04.134 | HTC.05.134 | HTC.06.134 | HTC.07.134 |
| HTC.08.134 | HTC.09.134 | HTC.10.134 | HTC.11.134 |

CHF.XX.YY: Critical heat flux (See “Critical Heat Flux” on page 276.)

* CHF: Identifies the critical heat flux.
* XX.YZ: Identifies methodology:
* If XX = PG: PG correlations:
* Y = P: power.
* Y = G: geometry.
* Y = F: flux.
* Y = B: basic.
* Z = T: tube.
* Z = A: annulus.
* Z = B: bundle
* If XX= LT - lookup table method:
* YZ = GR

**Table 14: Critical Heat Flux**

|  |  |  |
| --- | --- | --- |
| CHF.PG.PT | CHF.PG.PA | CHF.PG.PB |
| CHF.PG.GT | CHF.PG.GA | CHF.PG.GB |
| CHF.PG.FT | CHF.PG.FA | CHF.PG.FB |
| CHF.PG.BT | CHF.PG.BA | CHF.PG.BB |
| CHF.LT.GR |  |  |

GAP.CON.XX: Gap thermal conductivity from gap conductance model (See “Gap thermal conductivity from gap conductance model).

* XX: defines a temperature range.
* AT: uncertainty multiplier applied for all temperatures.
* LE: uncertainty multiplier applied for temperatures less than or equal to the specified value in W9 of **Cards 29000001 - 29001000**.
* GT: uncertainty multiplier applied for temperatures greater than the specified value in W9 of **Cards 29000001 - 29001000**..

Table 15: Gap thermal conductivity from gap conductance model

|  |
| --- |
| GAP.CON.AT |
| GAP.CON.LE |
| GAP.CON.GT |

VIS.XX.YY: Viscosity (See “Viscosity” on page 277.)

* XX: type of water.
* LW: light water
* HW: heavy water.

YY: fluid state.

* LIQ: liquid.
* VAP: vapor.

**Table 16: Viscosity**

|  |  |
| --- | --- |
| VIS.LW.LIQ | VIS.LW.VAP |
| VIS.HW.LIQ | VIS.HW.VAP |

CON.XX.YY: Thermal conductivity (See “Thermal conductivity” on page 277.).

* XX: type of water.
* LW: light water.
* HW: heavy water.
* YY: fluid state.
* LIQ: liquid.
* VAP: vapour

**Table 17: Thermal conductivity**

|  |  |
| --- | --- |
| CON.LW.LIQ | CON.LW.VAP |
| CON.HW.LIQ | CON.HW.VAP |

SFT.XX.ZZ: Surface tension.

* XX: type of water.
* LW: light water.
* HW: heavy water.
* ZZ: not applicable, always enter LV.

**A28.3 Cards 291DDWWW, Input Parameters Uncertainty Distribution Information**

**A28.3.1 Cards 291DD000, Distribution Type Information**

These cards are required and enter the distribution type data for a DD set.

* W1(A) Alphanumeric definition of the distribution type. Three types of distribution are allowed. If ND is entered, the normal distribution will be used for the random sampling process. If UD is entered, the uniform distribution will be used for the random sampling process. If TD, the trapezoidal distribution will be used for the random sampling process.

The next four words are the characteristic parameters defining the distribution type entered in W1.

* W2(R) If definition entered in W3 is ND, the required quantity is the mean. If definition entered in W3 is UD, the required quantity is the minimum value. If definition entered in W3 is TD, the required quantity is the lower left limit.
* W3(R) If definition entered in W3 is ND, the required quantity is the standard deviation. If definition entered in W3 is UD, the required quantity is the maximum value. If definition entered in W3 is TD, the required quantity is the upper left limit.
* W4(R) If definition entered in W3 is TD, the required quantity is the upper right limit. In other cases enter 0.0.
* W5(R) If definition entered in W3 is TD, the required quantity is the lower right limit. In other cases enter 0.0.

**A28.3.2 Cards 291DDWWW, Weight Information**

One or more input quantities to be modified as part of the uncertainty analysis are entered on this card using four quantities in each set. Each set may enter one or more quantities. One or more sets may be entered on each card. DD characters indicate a distribution type and its parameters. Each WW within a DD indicate weight to be using the DD distribution type. Finally, X indicates input quantities to be modified using the WW weight within the DD distribution type.

Each input quantity to be modified must appear in the input deck.

* W1(R) Weight related number. If -1.0 is entered, a weight will be computed according to W2 - W7 entered information. If a positive non-zero quantity is entered, it will be used as the weight for all uncertainty code runs. Also note that the options in W2 affect the usage of W1.
* W2(I) This number consists of two digits and a sign, -wn. The minus sign, if entered, will reduce the weight such that the product of the base value and the weight is not greater than 1.0.

The digit w controls both the computation and the application of the weights.

* If the digit is 0, the weight is the quantity entered in W1 and thus W1 must be positive non zero.
* If the digit is 1, the previously computed or entered weight will be used and thus W1 must be 0.0. The previously used weight is from a previous set on this card or previous cards.
* If the digit is 2, a weight is computed and used for all the words within this set.
* If the digit is 3, a different weight is computed for each word within this set. If the user desires a different user specified weight for each word, a set must be entered for each word.

The digit n allows normalization over a selected range of weights. The normalization consists of applying an additional factor such that the sum of the resulting weights times the base values is equal to the sum of the base values.

* A digit of 1 indicates the start of a normalization section.
* If the digit is 2, the normalization is terminated with the last word specified in the set.
* If the digit is 3, the normalization section begins with the first word of the set and ends with the last word of the set.
* If the digit is 0, the state of normalization not being done or being done is continued over the words in the set.
* W3(I) Card number containing quantities to be modified.
* W4(I) Word number of the first quantity in the card to be modified.
* W5(I) Word number of the last quantity in the card to be modified.
* W6(I) Skip factor. This quantity must be entered even if it’s equal to one.

**A28.4 Cards 29200000 - 29209999, Selection of Run Numbers for Post Processing**

The post processing phase reads information from the setup phase, time history information from the base run and several uncertainty runs, and from that information, generates rank matrices and graphs of uncertainty bounds.

Information from the base case is always included in the post processing analysis. These cards select which of the runs are to be included in the post processing and allows the user to select all runs or to ignore simulation runs which are judged to be unsatisfactory.

One or more of these cards are required for the post processing phase of the uncertainty analysis. Card numbers need not be consecutive. Runs during the simulation phase are numbered from 0 up to the maximum established during the setup phase. The run corresponding to the base case is numbered 0 and uncertainty runs are numbered from 1 up to the maximum. Using one or two words sets, the number of either a single uncertainty run or the numbers of a set of consecutive uncertainty runs is selected. The words entered on these cards must be in increasing run number. A positive run number followed by a negative run number is a two-words set and indicates a range of run numbers. A one word set is indicated by a positive number followed by a positive number.

W1(I) A run number or the first number of a two-words set indicating a range of consecutive run numbers.

W2(I) A positive number indicating another single run number or a negative number indicating the second word of a range.

... Enter additional one or two words sets as needed. For example entering 1, 3, -59 would indicate runs 1, 3, 4, 5, 6, ..., 59.

**A28.5 Cards 20800000 - 20810000, Selection of Output Uncertainty Quantities**

These cards 20800000 - 20810000 select which of the simulation results are to have rank matrices and bounds computed. The format of these cards which is used in the post processing phase of the uncertainty analysis is the same as the 20800000 - 20810000 cards described in Section A1.6. The quantities selected on these cards indicate the quantities to be processed in the post processing phase. However the indicated selected quantities must be present in the plot records of the base run and each of the uncertainty runs. If any the selected data is missing in any of the runs the post processing phase will be terminated and no results generated. To ensure that the selected quantities are present the following procedure is strongly recommended. The selection of the range of 2080000 - 20810000 numbers should be towards the high end such as 20809000 - 20810000 to differentiate these cards which specify uncertainty quantities from the normal 208XXXXX cards use to select additional plot variables. The cards specifying the uncertainty quantities should be added to the input deck for each simulation runs. Inserting the 208XXXXX cards from the uncertainty runs is recommended even if the simulation deck already specifies the quantity in its 208XXXXX cards. The duplication does cause an input failure and does not lead in an increase of plot records.