

Appendix G

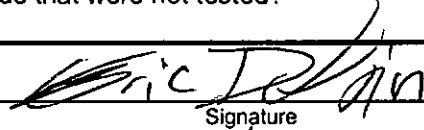
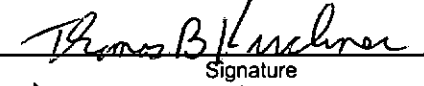


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| <p style="text-align: center;"><b>NUCLEAR<br/>WASTE<br/>MANAGEMENT<br/>PROCEDURE</b></p> <p><small>Sandia<br/>National<br/>Laboratories</small></p> | <h2 style="margin: 0;">User's Manual Criteria</h2> | <p><b>Form Number:<br/>NP 19-1-6</b></p> <p><b>Page 1 of 1</b></p> |
|---|--|--|

**Does the user's manual contain as appropriate:**

- 1. **Software Name:**           LHS
- 2. **Software Version:**           2.42
- 3. **Document Version:**           2.42
- 4. **ERMS #:**           538374

Prior to sign-off of the User's Manual, all items shall be appropriately addressed by the code sponsor so that "Yes" or "N/A" may be checked. Include this form as part of the User's Manual.

- 5. A statement(s) of functional requirements (consistent with those in the RD) and system limitations?  Yes
- 6. An explanation of the mathematical model and numerical models, where applicable as based on code functionality?  Yes  N/A
- 7. Physical and mathematical assumptions, where applicable as based on code functionality?  Yes  N/A
- 8. The capabilities and limitations inherent in the software?  Yes
- 9. Instructions that describe the user's interaction with the software?  Yes
- 10. The identification of input parameters, formats, and valid ranges?  Yes
- 11. Messages initiated as a result of improper input and how the user can respond?  Yes
- 12. The identification and description of output specifications and formats?  Yes
- 13. A description of any required training necessary to use the software?  Yes
- 14. The identification of components of the code that were not tested?  Yes

|   |  |                        |
|---|--|------------------------|
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**Key for check boxes above:**

- Check **Yes** for each item reviewed and found acceptable
- Check **N/A** for items not applicable, where applicable as based on code functionality

Information Only

**WIPP PA**

**User's Manual**

**for**

**LHS**

**Version 2.42**

**Version 2.42**

**ERMS # 538374**

**JANUARY 2005**

**Information Only**

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## 1.0 INTRODUCTION

This document serves as the User's Manual for the Latin hypercube sampling code, LHS, as used in the Waste Isolation Pilot Plant (WIPP) Performance Assessment (PA) calculation. As such, it provides an overview of LHS and describes its code architecture.

### 1.1 Software Identifier:

Code Name: LHS  
WIPP Prefix: LHS2  
Version Number: 2.42

### 1.2 Points of Contact:

#### Code Sponsor:

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Sandia National Laboratories  
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### 1.3 Code Overview

The LHS program samples distributions of input parameters using either normal Monte Carlo sampling or efficient Latin Hypercube Sampling. LHS permits correlations (restricted pairings) between parameters. Latin Hypercube sampling reduces the minimum number of sample vectors required to obtain reasonable estimates for various statistical properties of a distribution (Iman and Shortencarier, 1984). Only Latin hypercube sampling is used for WIPP PA.

LHS is the WIPP's constrained Monte Carlo sampling code. Several WIPP codes, including LHS, are exercised sequentially as triads of codes. In each such case, the three codes are QAed individually, although they are exercised in sequence, as a group. It is recommended that they be learned as a group. The main code, treated herein, is called LHS. Its preprocessor code is called PRELHS, and its post processor is called POSTLHS.

## 2.0 FUNCTIONAL REQUIREMENTS

The requirements for LHS are listed in the *WIPP PA Requirements Document for LHS Version 2.42* (WIPP-PA 2005a). The requirements are repeated here for the reader's convenience.

### 2.1 Functional Requirements

R.1 LHS performs Latin hypercube sampling.

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- R.2 Generate the distribution for each parameter to be sampled: NORMAL, LOGNORMAL, UNIFORM, LOGUNIFORM, USER DISTRIBUTIONS (Cumulative, Data, Delta), TRIANGULAR, STUDENT, LOGSTUDENT.
  - R.3 Correctly use the general input data sets used for WIPP/PA analysis: TITLE, NOBS, RANDOM SEED, OUTPUT.
  - R.4 Generate a correlation matrix as requested.

## 2.2 Attribute Requirements

- R.5 All modules will be called or the reason for all uncalled modules will be explained.

## 2.3 External Interface Requirements

- R.6 LHS can read the ASCII Text output file from PRELHS.
- R.7 LHS can read a user generated ASCII input file created using the format used by PRELHS.
- R.8 LHS generates one text output data file suitable for use as input by the code POSTLHS version 4.07 or higher. This file contains the values of the sampled parameters of which the Latin hypercube sample consists.
- R.9 LHS generates one text debug file.

## 2.4 Other Requirements

- R.10 LHS can detect invalid input in WIPP PA data sets.

## 3.0 REQUIRED USER TRAINING AND/OR BACKGROUND

To exercise LHS, users should have basic knowledge of (1) OpenVMS, (2) Digital Command Language, and (3) an overall understanding of the WIPP PA database, which is used in virtually every WIPP code set (Rechard, 1992; Rechard et al. 1993). They should also have (4) access to the WIPP cluster of Alpha computers with an OpenVMS (version 7.3) operating system, or their functional equivalents.

To manipulate and/or interpret the results of LHS, users should have (1) a basic understanding of introductory probability theory, and especially sampling theory and probability distribution functions, (2) a fairly complete, if basic, overview understanding of the WIPP PA process, and especially of, the uncertain physical parameters that are used, the data distributions they lead to, how distributions for different physical parameters are either related or not related, the rational basis of uncertainty sampling methods, and the use of input-data vectors in WIPP PAs (WIPP PA Dept. [5 volumes], 1992a-e), and (3) an operational familiarity with and general understanding of LHS's preprocessor code, PRELHS (WIPP-PA 2001).

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## 4.0 DESCRIPTION OF THE MODELS AND METHODS

LHS neither models physical phenomena nor solves differential equations that model physical process. Its principal role in WIPP PA is to sample, using Latin hypercube sampling methods, distributions that represent reasonable values of WIPP input-parameter data. LHS treats each parameter independently but permits user-specified correlations (restricted pairings) between parameters.

The situation generally addressed by LHS is the following. We are given a variable of interest,  $Y$ , that is a dependent function of several other variables, including a discrete set of physical parameters  $X_1, X_2, \dots, X_k$ . However, due to unresolvable uncertainties, the physical parameters are not specifiable as single, unique numbers. Rather, they are characterized by ranges or distributions of values together with probabilities of occurrence associated with the values included in the distributions. A question of central concern is how does  $Y$  vary when the  $X$ s vary?

The conventional approach to addressing this question is to use Monte Carlo sampling. By sampling repeatedly from the given joint probability density function of the  $X$ s and evaluating  $Y$  for each sample, the distribution of  $Y$ , its mean, percentiles, etc., can be estimated. However, to receive a reasonable estimate, a large number of samples must be taken, and a large number of evaluations of  $Y$  must be performed. If  $Y$  is computationally expensive to evaluate, this can be infeasible. Additionally, Monte Carlo sampling is inefficient in the sense that most of its samples will be taken from the higher probability of occurrence portions of the distributions. Thus, extreme values, which usually reside toward the outer wings of the distributions tend to be ignored for all but very large samples. To remedy this shortcoming, an alternative constrained sampling system was introduced. The particular system selected is known as Latin hypercube sampling.

Latin hypercube sampling was developed by McKay, Conover, and Beckman (1979). Much of the following discussion of the methodology of LHS is from Iman and Shortencarier (1984) and Wyss and Jorgensen (1998). For a more detailed description of LHS, see Iman et al. (1981a, 1981b) for sensitivity analysis techniques. A tutorial on LHS may be found in Iman and Conover (1982a). A comparison of Latin hypercube sampling with other sampling techniques can be found in Iman and Helton (1985).

### 4.1 Description of Methods

For regulatory PA calculations, LHS employs only Latin hypercube sampling to create parameter samples for use by other codes. Thus, we only discuss this type of sampling and do not discuss traditional Monte Carlo sampling.

#### 4.1.1 Sampling from a Truncated Distribution

When LHS samples from NORMAL, LOGNORMAL, STUDENT, and LOGSTUDENT distributions, it samples from the truncated distributions. LHS version 2.42 samples these



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distributions from a range bounded below by the 0.01 quantile and above by the 0.99 quantile. LHS employs the following algorithm to create N samples from one of these distributions:

- 1) Initialize STRPT=0.01, i=0.
- 2) While i<N
  - a) Sample r randomly from a uniform distribution on [0,1].
  - b) Scale r by  $p = \text{STRPT} + r \cdot (0.98/N)$
  - c) Compute  $s(i) = F^{-1}(p)$ , where  $F^{-1}(x)$  denotes the inverse cumulative distribution function (CDF)
  - d) Update STRPT and i:  $\text{STRPT} = \text{STRPT} + (0.98/N)$ ,  $i = i + 1$
- 3) End

#### 4.1.2 Sampling from an Untruncated Distribution

When LHS samples from a distribution that is not truncated, the procedure is similar to the method outlined above. LHS employs the following algorithm to create N samples from an untruncated distribution:

- 1) Initialize STRPT=0.00, i=0.
- 2) While i<N
  - a) Sample r randomly from a uniform distribution on [0,1].
  - b) Scale r by  $p = \text{STRPT} + r \cdot (1/N)$
  - c) Compute  $s(i) = F^{-1}(p)$ , where  $F^{-1}(x)$  denotes the inverse cumulative distribution function (CDF)
  - d) Update STRPT and i:  $\text{STRPT} = \text{STRPT} + (1/N)$ ,  $i = i + 1$
- 3) End

#### 4.1.3 Pairing the Sampled Values

When all the distributions given in the input file have been sampled, subroutines are called to arrange the sampled outcomes for each distribution type according to the correlation structure specified in the input file. The completed sample is then written to the output files. For more detail on how LHS arranges the sampled outcomes according to correlation structure, see the *Design Document for LHS Version 2.42 (WIPP-PA 2005b)*.

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## 5.0 CAPABILITIES AND LIMITATIONS INHERENT IN THE SOFTWARE

LHS is capable of performing Latin-hypercube sampling, a form of stratified Monte Carlo sampling. It can sample 17 distribution types, although only 10 of those are contemplated for use in the WIPP PA certification calculations. The chosen 10 are: NORMAL, LOGNORMAL, UNIFORM, LOGUNIFORM, CUMULATIVE USER, DATA USER, DELTA USER, STUDENT, LOGSTUDENT, and TRIANGULAR distributions. The other seven distribution types (which LHS can sample, but which are *not* contemplated for WIPP-PA certification calculations) are BETA, UNIFORM\*, LOGUNIFORM\*, HISTOGRAM USER, EXPONENTIAL, RAYLEIGH, and RAYLEXP.

For purposes of the WIPP PA certification calculations, sampled values for NORMAL and LOGNORMAL distributions are constrained to be no smaller than the smallest input value and no larger than the largest input value, even though those values represent 0.01 and 0.99 quantiles. STUDENT and LOGSTUDENT distributions are also constrained to the 0.01 and 0.99 quantiles.

To execute, LHS reads the ASCII text output transfer file exactly as it was produced by PRELHS (see the WIPP PA User's Manual for PRELHS, Version 2.30 (WIPP-PA 2001)). Contained in that file are input records describing the various types of distributions to be generated and keywords used to control the run, including, for example: TITLE, NOBS, RANDOM SEED, and OUTPUT.

LHS is capable of generating a correlation matrix of sampled distribution data as directed by input from PRELHS's ASCII text transfer file. Specific keywords that can be read and acted upon by LHS, but will *not* be used for the certification calculation, are: NREPS, RANDOM PAIRING, and RANDOM SAMPLE.

LHS produces two ASCII output files during each run. (i) The main ASCII output file serves solely as the input control file for POSTLHS. It contains echoed input file information, the raw values for the sampled distribution outcomes in tabular format for each distribution type, and tables of rank values for the sampled distribution outcomes. Depending on the keywords provided, additional output tables may be present showing raw and rank correlation tables for the sampled distributions, and histogram plots of each sampled distribution. Included with the distribution histograms is a listing of statistical information applicable to the distribution portrayed in the plot. (ii) The secondary ASCII text output file contains the raw sampled distribution data on a vector-by-vector basis. No other information is present in the second file.

LHS is programmed using ANSI X3.9-1978 FORTRAN 77, except that comments are written in lower-case characters. At present, LHS is limited to the generation of 100 parameter distributions, 10,000 outcome vectors for a single sampling run, and 50 distribution correlations specified in the input file. These limits may be increased, but the code would have to be recompiled.

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## 6.0 USER INTERACTIONS WITH THE SOFTWARE

### 6.1 LHS's Input/Output File Structure

LHS requires the user to specify the names of (i) certain already-existent input files and of (ii) the output files the code will create as a result of being exercised. The following section discusses the file specification requirements of LHS.

#### 6.1.1 LHS's Input TEXT TRANSFER File

LHS's input file is, verbatim, the ASCII text output file from PRELHS. LHS does have the possibility of running with a user-generated input file, but **that option will not be used for regulatory calculations and therefore it will not be discussed herein**. LHS's input file is thus dual purpose. It serves (i) as a control file that directs LHS's function by specifying the code-execution keywords in a format suitable for direct usage by LHS, and (ii) as a data file that provides the parameter-distribution data on which LHS will operate. The user specifies the name of this input file by assigning it to the logical LHS2\_UIF\$INPUT.

An example of an LHS input file is the PRELHS output transfer file LHS2\_T1.INP. It is described in detail in Section 7.0, below, and listed in full in Appendix A.

#### 6.1.2 LHS's Output TEXT File

LHS's results are written to an ASCII text file, which, in turn, is forwarded to LHS's post processor. It contains the outcomes of the Latin-Hypercube sampling procedure, it echoes LHS's input file, and it shows parameter-correlation tables and histogram plots of each sampled distribution. The user specifies the name of this output file by assigning it to the logical LHS2\_OUT\$OUTPUT.

An example of LHS's output text file is given in LHS2\_T1.OUT. This file is described in detail in Section 9.0, below, and listed in full in Appendix B.

#### 6.1.3 LHS's Output DEBUG File

The optional output debugging text file contains the actual numerical values LHS produces for each sampled parameter, on an outcome-by-outcome basis. The information in this file is the same as that available in the output ASCII text file, but without the inclusion of descriptive text or plots. The user specifies the name of this output file by assigning it to the logical LHS2\_DBG\$OUTPUT.

An example of a LHS debugging text file is LHS2\_T1.DBG. It is reproduced in full in Appendix C of this document.

## 6.2 Exercising LHS

LHS can be run by COMMAND file, or it can be run interactively if the user types the proper commands directly. In COMMAND-file mode, LHS can execute either interactively or in batch mode. Given those capabilities, it is recommended that COMMAND-file mode be employed as a rule. It is the method that will be applied in regulatory calculations.

A COMMAND file that runs LHS is shown in Figure 1.

```
$!  
$! DEFINE INPUT, OUTPUT, & SCRATCH FILES.  RUN THE LHS CODE.  
$!  
$ DEFINE LHS2_UIF$INPUT          LHS2_T1.INP  
$ DEFINE LHS2_OUT$OUTPUT        LHS2_T1.OUT  
$ DEFINE LHS2_DBG$OUTPUT        LHS2_T1.DBG  
$ DEFINE LHS2_NO2$SCRATCH       FOR002.DAT  
$ DEFINE LHS2_NO3$SCRATCH       FOR003.DAT  
$ DEFINE LHS2_NO4$SCRATCH       FOR004.DAT  
$ DEFINE LHS2_NO7$SCRATCH       FOR007.DAT  
$ DEFINE LHS2_NO8$SCRATCH       FOR008.DAT  
$ DEFINE LHS2_NO9$SCRATCH       FOR009.DAT  
$!  
$ RUN WP$PRODROOT: [LHS.EXE] LHS_QA0242.EXE  
$ DEASSIGN LHS2_UIF$INPUT  
$ DEASSIGN LHS2_OUT$OUTPUT  
$ DEASSIGN LHS2_DBG$OUTPUT  
$ DEASSIGN LHS2_NO2$SCRATCH  
$ DEASSIGN LHS2_NO3$SCRATCH  
$ DEASSIGN LHS2_NO4$SCRATCH  
$ DEASSIGN LHS2_NO7$SCRATCH  
$ DEASSIGN LHS2_NO8$SCRATCH  
$ DEASSIGN LHS2_NO9$SCRATCH  
$!  
$ EXIT
```

Figure 1 Example of a COMMAND file to run LHS

In the above COMMAND file, nine VMS "DEFINE" commands are used to link the names of user-selected input and output files (far right side of the DEFINE statements) with the logical symbols that define those same files internally within LHS (near right side of the DEFINE statements). The first three DEFINE commands link LHS's input and output files with their corresponding logical symbols. The remaining six DEFINE commands link LHS's internal scratch-file logical symbols with their corresponding internally-chosen file names. The scratch-file names are designed to indicate the unit number of each file. Since scratch files are opened, used, closed, and deleted during execution of LHS, they are of no consequence to users.

The DEFINE commands are followed by a RUN command that directs the computer to run the LHS executable located in the "PRODUCTION" directory. That command is followed by a series of DEASSIGN commands that deactivate the logical-symbol/file-assignment matches made prior to the run. The DEASSIGN step is primarily a *good housekeeping* policy. It is not a requirement. However, if DEASSIGN commands are not implemented and the code is then run interactively, it is

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possible that subsequent runs might access the wrong input files. For that reason, it is prudent to apply the DEASSIGN commands.

Any COMMAND file similar to the one listed above can be run interactively. If the file is named LHS.COM , it can be executed at the VMS \$ prompt as follows:

```
$ @LHS.COM
```

Interactive runs without command files are possible, but they are not recommended. Nor are they anticipated in regulatory calculations. To execute LHS interactively, the user, at a minimum, must type the following VMS commands after the system prompt:

```
$ DEFINE LHS2_UIF$INPUT      LHS2_T1.INP
```

```
$ DEFINE LHS2_OUT$OUTPUT    LHS2_T1.OUT
```

```
$ DEFINE LHS2_DBG$OUTPUT    LHS2_T1.DBG
```

```
$ RUN WP$PRODROOT:[LHS.EXE] LHS_QA0242.EXE
```

Since the user never sees LHS's scratch files, it is quite acceptable that they be defined internally. LHS will assign them the names corresponding to their logical symbols.

---

## 7.0 DESCRIPTION OF THE INPUT FILES

PRELHS creates an ASCII output transfer file (see the User's Manual for PRELHS version 2.30, WIPP-PA 2001) that ordinarily serves as LHS's input control file. That file is described in detail in the paragraphs that follow. A sample listing of the LHS input file is given in Appendix A of this manual. It contains all of the information necessary for LHS to exercise and thereby create a sample. The input file has as its first and last record a title line created by PRELHS from information found in the WIPP PA database identifying the database's title and version number. Also included is the date and time stamp signifying when PRELHS created the LHS input file. This title record is carried through to the completion of the LHS run and appears on the ASCII text output file. After the initial title record, a second title record gives a descriptive title that identifies the LHS input file. It serves no other purpose.

Following the two title records, the LHS input file lists code execution keywords. In the case of the sample file in Appendix A, keywords NOBS and RANDOM SEED appear and specify that a sample of 75 outcomes will be created by LHS, along with specifying the value of the starting random seed as 933090934. Next comes the information necessary to calculate each of the distributions to be included in the sample. For the example file in Appendix A, ten data distribution types are included. They are NORMAL, LOGNORMAL, UNIFORM, LOGUNIFORM, CUMULATIVE USER DISTRIBUTION, DATA USER DISTRIBUTION, DELTA USER DISTRIBUTION, STUDENT, LOGSTUDENT, and TRIANGULAR. These 10 distributions correspond to the data distribution types that will be utilized for the regulatory calculation.

After specification of the data distribution input, the LHS input file in Appendix A lists further input. The CORRELATION MATRIX keyword is listed, followed by the various correlation pairs and the desired correlation values. Next, the OUTPUT keyword is listed, followed by its attendant keywords: CORR, HIST, and DATA. These keywords are used to instruct LHS as to which of three types of output are to be prepared and written to one of the two LHS output files. The last record in the PRELHS output transfer file is a repeat of the title record found at the beginning of the file.

The LHS input file is designed to be used without modification. Therefore, for the purposes of regulatory calculations, it will not be edited or otherwise modified in any way after it has been created by PRELHS.

### 7.1 Detailed Description of LHS Input File Entries

The following is a description of LHS's input file entries. Each paragraph gives the entry name and a brief description of its function. Please note that some input keywords applicable to the LHS code are not used in regulatory calculations.

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## LHS KEYWORD COMMANDS USED IN REGULATORY CALCULATIONS

The following commands are used by LHS to set up the run or control its execution.

**TITLE**                    The TITLE record specifies the title for the LHS run. The record after TITLE may contain up to 100 alphanumeric characters. An example of usage of this keyword follows:  
TITLE CMS TEST INPUT FILE FOR THE LHS CODE

**NOBS**                    The NOBS record is used, with its associated parameter value, *no.\_obs*, to specify the number of vectors to be created for a sample (sample size [ $n_v$ ]). An example of usage of this keyword follows:  
NOBS 75

**RANDOM SEED**        THE RANDOM SEED record, along with its associated parameter value, *number*, is used to specify the starting point for the random number generator. An example of usage of this keyword follows:  
RANDOM SEED 933090934

### CORRELATION MATRIX

The CORRELATION MATRIX record, along with its associated parameter values, establishes the desired rank correlation among variables. If this parameter is omitted, all pairwise correlations will be assumed to be 0. The CORRELATION MATRIX record is followed by one or more lines containing the number of pairs to be rank correlated, *no.\_rank\_corr*, followed by that many ordered triplets *no.\_rank\_corr* specifying the number IDs of the two variables being correlated and their rank correlation. An example of usage of this keyword follows:

```
CORRELATION MATRIX
4
1 3 0.999
2 5 0.950
4 6 0.800
5 2 0.950
```

**OUTPUT**                The OUTPUT record, along with its associated parameter keywords CORR, HIST, and DATA, controls the amount and type of output generated. The parameter keywords are defined as follows:  
CORR signifies that both the raw and rank correlation matrices of the sample will be printed out in tabular form.

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HIST signifies that histograms and associated statistical information will be printed for each variable in the sample.

DATA signifies that the individual values of each sampled variable will be printed, followed by the ranks of each variable. For the regulatory calculation, this output control keyword must be specified in conjunction with the OUTPUT keyword.

Examples of usage of the OUTPUT keyword follow:

```
OUTPUT CORR HIST DATA
OUTPUT CORR DATA
OUTPUT HIST DATA
```

### LHS COMMANDS *NOT* USED IN REGULATORY CALCULATIONS

The following LHS execution commands may be included in the input file, as described previously. **However, these particular commands are not to be used for regulatory calculations.**

**NREPS**                    The NREPS record specifies the number of repetitions of the sample (each with a sample size of *no.\_obs*. If not specified, NREPS defaults to 1).

**RANDOM PAIRING**  
When present, the RANDOM PAIRING record specifies that sample values are to be paired randomly; otherwise, sample values are restrictively paired subject to any conditions under the CORRELATION MATRIX parameter.  
If both RANDOM PAIRING and CORRELATION MATRIX records appear, the former is ignored with a message to that effect printed after the correlation matrix.

**RANDOM SAMPLE**  
When present, the RANDOM SAMPLE record specifies that a random sample is to be generated; otherwise, a Latin hypercube sample is generated.

A description of the input for the different distribution types capable of being sampled by LHS is included here. Since all of the distribution information will be present on the LHS input file generated by PRELHS, the treatment of the distribution parameters is brief. The first 10 distribution types listed cover the types used for the certification calculation. The remaining seven entries will pertain to distribution types that can be processed by LHS but will not be used for the final certification calculation.



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## LHS DISTRIBUTION TYPES *USED* IN THE REGULATORY CALCULATION

- NORMAL**            The NORMAL record specifies a truncated normal distribution. An example of the distribution format follows:  
NORMAL        material\_name    parameter\_name  
                  minimum    maximum
- LOGNORMAL**        The LOGNORMAL record specifies a truncated LOGNORMAL distribution. An example of the distribution format follows:  
LOGNORMAL    material\_name    parameter\_name  
                  minimum    maximum
- UNIFORM**            The UNIFORM record specifies a uniform distribution. An example of the distribution format follows:  
UNIFORM        material\_name    parameter\_name  
                  minimum    maximum
- LOGUNIFORM**        The LOGUNIFORM record specifies a loguniform distribution. An example of the distribution format follows:  
LOGUNIFORM    material\_name    parameter\_name  
                  minimum    maximum
- USER DISTRIBUTION (CUMULATIVE)**  
The USER DISTRIBUTION (CUMULATIVE) record specifies a cumulative user supplied distribution. An example of the distribution format follows:  
USER DISTRIBUTION (CUMULATIVE) material\_name parameter\_name  
                  nval        SPECIFIED    CONTINUOUS  
                  value1     probability1  
                  value2     probability2  
                  ...         ...  
                  value<sub>nval</sub>    0.
- USER DISTRIBUTION (DATA)**  
The USER DISTRIBUTION (DATA) record specifies a data user supplied distribution. An example of the distribution format follows:  
USER DISTRIBUTION (DATA)    material\_name    parameter\_name  
                  nval        EQUAL        CONTINUOUS  
                  value1    value2 ... value<sub>nval</sub>

---

## USER DISTRIBUTION (DELTA)

The USER DISTRIBUTION (DELTA) record specifies a delta user-supplied distribution. An example of the distribution format follows:

```
USER DISTRIBUTION (DELTA)  material_name  parameter_name
      nval      SPECIFIED      DISCRETE
      value1    probability1
      value2    probability2
      ...
      valuenval  probabilitynval
```

## STUDENT

The STUDENT record specifies a truncated student-t distribution. An example of the distribution format follows:

```
STUDENT  material_name  parameter_name
      nval
      value1  value2 ... valuenval
```

## LOGSTUDENT

An

The LOGSTUDENT record specifies a truncated logstudent-t distribution.

example of the distribution format follows:

```
LOGSTUDENT  material_name  parameter_name
      nval
      value1  value2 ... valuenval
```

## TRIANGULAR

The TRIANGULAR record specifies a triangular distribution. An example of the distribution format follows:

```
TRIANGULAR  material_name  parameter_name
      minimum apex maximum
```

## LHS DISTRIBUTION TYPES *NOT USED* IN THE REGULATORY CALCULATION

### BETA

The BETA record specifies a beta distribution. An example of the distribution format follows:

```
BETA  material_name  parameter_name
      minimum maximum shape_p shape_q
```

### EXPONENTIAL

The EXPONENTIAL record specifies an exponential distribution. An example of the distribution format follows:

```
EXPONENTIAL  material_name  parameter_name
      minimum maximum lambda
```

### RAYLEIGH

The RAYLEIGH record specifies a Rayleigh distribution. An example of the distribution format follows:

```
RAYLEIGH  material_name  parameter_name
      minimum maximum lambda
```

Information Only

**RAYLEXP**            The RAYLEXP record specifies a Rayleigh-exponential distribution. An example of the distribution format follows:

```
RAYLEXP     material_name parameter_name  
            minimum crossover maximum lambda
```

**UNIFORM\***           The UNIFORM\* record requests a uniform distribution with specific sampling frequencies on subintervals. An example of the distribution format follows:

```
UNIFORM*    material_name parameter_name  
            m freq1 ... freqm c1 ... cm+1
```

**LOGUNIFORM\***

The LOGUNIFORM\* record requests a loguniform distribution with specific sampling frequency on subintervals. An example of the distribution format follows:

```
LOGUNIFORM* material_name parameter_name  
            m freq1 ... freqm c1 ... cm+1
```

**USER DISTRIBUTION (CUMHISTOGRAM)**

The USER DISTRIBUTION (CUMHISTOGRAM) record specifies a cumhistogram user-supplied distribution. An example of the distribution format follows:

```
USER DISTRIBUTION (CUMHISTOGRAM) material_name parameter_name  
            nval     SPECIFIED     DISCRETE  
            value1    probability1  
            value2    probability2  
            ...        ...  
            valuenval probabilitynval
```

---

## 8.0 ERROR MESSAGES

Detailed error detection is implemented in LHS through an assortment of error-checking subroutines. Errors detected during execution result in the generation of corresponding error messages written to the ASCII text output file. If the code regards the error as serious, and that is generally the case, the run will abort after an error message has been written.

LHS's error messages are numerous and specific in nature. In most cases, the error message describes the subroutine where the error occurred, and is accompanied by text describing the error. Often that is sufficient to track the problem down, especially if a "debug" version of the code is available. "Debug" versions of LHS allow interaction with the code during its execution and facilitate tracking down errors. However, the user should always perform a detailed visual inspection of the *entire* ASCII output file to assure (i) the output looks as it should and (ii) that no error messages have appeared.

LHS error messages fall into several categories. Numerous error messages are devoted to improperly specified input data records. All of the execution keywords, problem size specifications, and distribution input data are checked for proper form. LHS is unable to determine whether a particular data distribution accurately reflects the physical information it is supposed to portray in the real world, but it is quite able to determine whether that information is entered in a syntactically correct way. LHS easily detects errors such as the maximum range being smaller than the minimum range for a given distribution.

Once the input file information has been successfully read, LHS checks to see if parameters set in the input file (such as the number of distributions to be sampled, the number of outcome vectors to be generated, and the number of distribution parameter correlations specified) exceed the limits imposed by maximum-value parameters specified internally. LHS also checks to see that at least a minimum number of distributions and sample outcome vectors have been specified.

As the code creates the sample for the various distributions, error checks are invoked that are internal to the subroutines used to calculate the distributions. This type of error checking is most prevalent in the generation of BETA distributions, distributions that will *not* be used in regulatory calculations. Lastly, LHS utilizes numerous error-checking routines to assure that the correlation table calculated during a run meets the mathematical tests it must pass to be deemed acceptable.

Table 1 lists the error messages printed to the ASCII text log file.

Table 1 Error messages written to the output file

| Subroutine | Statement  | Explanation   |
|------------|--|---|
| CHKDAT     | 'FOR THE ',A,'DISTRIBUTION THE LOWER LIMIT A ',G20.10,/,6X,'IS GREATER THAN OR EQUAL TO THE UPPER ',2 'LIMIT B   | Fatal Error: The lower bound for a distribution is greater than the upper bound.  |
|            | 'FOR THE ',A,'DISTRIBUTION THE LOWER LIMIT A ',G20.10,/,6X,'OR THE UPPER LIMIT B ',G20.10,/,6X,'SHOULD NOT BE LESS THAN OR EQUAL TO ZERO'  | Fatal Error: The lower limit for certain distributions cannot be less than 0.   |
|            | 'FOR THE BETA DISTRIBUTION THE PARAMETER P ', G20.10,/,6X,'OR THE PARAMETER Q ',G20.10,/,6X,'SHOULD ', 'NOT BE LESS THAN 0.0 OR NUMERICAL INSTABILITIES WILL ',OCCUR AS',/,6X,'A RESULT OF TRYING TO INVERT THE BETA ',DISTRIBUTION ON PORTIONS OF THE CURVE',/,6X,'WITH ',EXTREME SLOPES' | Fatal error: The parameter p cannot be less than 0 for the beta distribution.   |
| CHKDIM     | 'THE NUMBER OF VARIABLES REQUESTED ',J3,/,6X,' EXCEEDS THE MAXIMUM NUMBER OF VARIABLES CURRENTLY ', 'PERMITTED ',J3,/,6X,'PLEASE CONSULT THE USER MANUAL FOR', 'INSTRUCTIONS ON HOW TO ALLOW MORE VARIABLES'   | Fatal Error: The input file specified more than 100 variables to be sampled. (LHS allows for a maximum of 100 variables).                 |
|            | 'THE FOLLOWING DISTRIBUTION CARD REQUESTED ',I4, ' OBSERVATIONS',/,6X,'HOWEVER THE NOBS PARAMETER CARD ', 'REQUESTED ',I4,' OBSERVATIONS',/,6X,'THIS DISCREPANCY ', 'MUST BE RESOLVED BEFORE PROCESSING CAN CONTINUE'  | Fatal Error: The input file requested more than 10,000 observations of a distribution. (LHS allows for a maximum of 10,000 observations). |
| CHKEXP     | 'FOR THE EXPONENTIAL DISTRIBUTION THE PARAMETERS ', 'A,B ',2G20.10,/,6X,'HAVE BEEN INPUT IN THE INCORRECT ', 'ORDER',/,6X,'THE INTERVAL START (A) MUST BE LESS THAN ', 'THE INTERVAL END (B)'  | Fatal error: The lower bound for the exponential distribution is greater than the upper bound.  |
| CHKRAY     | 'FOR THE RAYLEIGH DISTRIBUTION THE PARAMETERS ', 'A,B ',2G20.10/6X,'HAVE BEEN INPUT IN THE INCORRECT ', 'ORDER',/,6X,'THE INTERVAL START (A) MUST BE LESS THAN ', 'THE INTERVAL END (B)'   | Fatal error: The lower bound for the Rayleigh distribution is greater than the upper bound.   |
| CHKREX     | 'FOR THE RAYLEIGH-EXPONENTIAL DISTRIBUTION, THE PARAMETERS ',5X,'A,B,C',3G20.10/6X,'HAVE BEEN INPUT IN AN INCORRECT ORDER.',5X,'THE INTERVAL START (A) MUST BE LESS THAN THE MIDPOINT (B)',5X,'AND THE MIDPOINT (B) MUST BE LESS THAN THE ENDPOINT (C).'                                   | Fatal error: The lower bound for the Rayleigh-exponential distribution is greater than the upper bound.                                   |
| CHKSTR     | 'FOR THE ',A,'DISTRIBUTION THE NUMBER OF ', 'SUBINTERVALS IS ZERO'   | Fatal error: Zero intervals are specified for the Uniform* or Loguniform* distributions.  |

|        |  |  |
|--------|--|--|
| CHKSTR | 'FOR THE 'A,'DISTRIBUTION THE NUMBER OF '<br>'SUBINTERVALS REQUESTED ',I3,/,6X,'IS<br>GREATER THAN THE ', 'MAXIMUM NUMBER OF<br>SUBINTERVALS CURRENTLY PERMITTED ',I3,<br>,/6X,'PLEASE CONSULT THE USER MANUAL FOR<br>INSTRUCTIONS ', 'ON HOW TO ALLOW MORE<br>SUBINTERVALS' | Fatal error: The input file has<br>specified more intervals for<br>the Uniform* or Loguniform*<br>distributions than LHS allows.   |
|        | 'FOR THE 'A,'DISTRIBUTION THE SUBINTERVAL ',<br>'LIMIT FOR SUBINTERVAL ',I3,/,6X,'IS LESS THAN<br>OR ', 'EQUAL TO ZERO '   | Fatal error: Zero or negative<br>intervals are specified for the<br>Uniform* or Loguniform*<br>distributions.  |
|        | 'ON THE 'A,'DISTRIBUTION FOR SUBINTERVAL ',<br>I3,' THE LOWER LIMIT ',G20.10,/,6X,'IS GREATER ',<br>'THAN OR EQUAL TO THE UPPER LIMIT '  | Fatal error: The lower bound<br>of a subinterval is greater<br>than or equal to the upper<br>bound of a subinterval for a<br>Uniform* or Loguniform*<br>distribution.        |
|        | 'FOR THE 'A,'DISTRIBUTION SUBINTERVAL ',I3, '<br>REQUESTED A NEGATIVE NUMBER OF<br>OBSERVATIONS'   | Fatal error: A negative<br>number of intervals are<br>specified for the Uniform* or<br>Loguniform* distributions.  |
| CHKTRI | 'FOR THE TRIANGULAR DISTRIBUTION THE<br>PARAMETERS ', 'A,B,C ',3G20.10,/,6X,'HAVE BEEN<br>INPUT IN THE INCORRECT ',<br>'ORDER',/,6X,'PLEASE CONSULT THE USER<br>MANUAL FOR ', 'INSTRUCTIONS ON THE ORDER<br>OF THE PARAMETERS'   | Fatal error: For the triangular<br>distribution, it is required that<br>A<B<C. This error message<br>prints out when A, B, and C<br>are specified in the incorrect<br>order. |
| CHKZRO | 'THE NUMBER OF OBSERVATIONS HAS NOT<br>BEEN ', 'SPECIFIED'   | Fatal error: the number of<br>observations has not been<br>set.  |
|        | 'NO VARIABLES HAVE BEEN SPECIFIED'   | Fatal error: No variables<br>have been specified.  |
|        | 'A RANDOM SEED HAS NOT BEEN SPECIFIED'   | Fatal error: No variables have<br>been specified.  |
| CMCRD  | 'THE CORRELATION BETWEEN VARIABLE ',I3,'<br>AND ', 'VARIABLE ',I3,' IS GREATER THAN ONE IN<br>ABSOLUTE ', 'VALUE '   | Fatal error: A correlation<br>between two variables has<br>magnitude greater than one.   |
|        | 'THE CORRELATION BETWEEN VARIABLE ',I3,'<br>AND ', 'VARIABLE ',I3,' IS NOT EQUAL TO ONE '  | Fatal error: A correlation<br>between a variable and itself<br>is not one.   |
|        | 'THE CORRELATION BETWEEN VARIABLE ',I3,'<br>AND ', 'VARIABLE ',I3,' IS ',F5.2,/,4X,' HOWEVER<br>ONLY ',I3, ' VARIABLES HAVE BEEN DEFINED'  | Fatal error: More<br>correlations than variables<br>have been specified.   |
| CORCAL | '0ERROR IN CORCAL - ALL VALUES FOR<br>VARIABLE ARE EQUAL (',2') TO AVOID DIVISION<br>BY ZERO EXECUTION IS BEING STOPPED.'  | Fatal error: All values of a<br>sampled variable are zero.<br>This will cause division by<br>zero when making the rank<br>correlation matrix.                                |
| DATSQZ | 'THE PARAMETER CARD 'A,'CONTAINS NO DATA'  | Fatal error: The parameter<br>does not contain any data.   |

|         |  |   |
|---------|--|---|
| DATSQZ  | 'THE PARAMETER CARD ',A,'CONTAINS THE ',<br>'NON-NUMERIC CHARACTER '   | Fatal error: The parameter specifies a non-numeric character when it should specify a numeric character.                                |
|         | 'THE DATA ON PARAMETER CARD ',A,'CONTAINS ',I2, ' DIGITS',/,6X,'THE MAXIMUM NUMBER OF DIGITS ALLOWED ', 'IS ',I2   | Fatal error: The parameter specifies more digits than allowed.  |
| DMFSD   | 'ROUNDING ERROR IN ROW ',I2  | Error: The correlation matrix cannot be inverted due to a rounding error.   |
|         | 'MATRIX IS SINGULAR AT ROW ',I2  | Error: The correlation matrix cannot be inverted because it is singular.  |
| HYPGEO  | 'IN HYPGEO, NO CONVERGENCE OF SERIES'  | Fatal error: When creating the beta distribution, the Gauss hypergeometric function does not converge.                                  |
| OUTCRD  | 'THE FOLLOWING OUTPUT OPTION CARD REQUESTED ', 'AN UNDEFINED OUTPUT OPTION',/,6X,'PLEASE CHECK THE ', 'USER MANUAL FOR THE CORRECT OUTPUT OPTION CARD ', 'SYNTAX'  | Fatal error: The input file requested an undefined output option.   |
| POSDEF  | 'THE INPUT RANK CORRELATION MATRIX IS NOT POSITIVE ', 'DEFINITE.',/, ' AN ITERATIVE PROCEDURE HAS FAILED TO ', 'PRODUCE A POSITIVE DEFINITE MATRIX AFTER 20 ITERATIONS.',/, ' THEREFORE, THE PROGRAM HAS BEEN TERMINATED.',/, ' THE ', ' USER NEEDS TO REEVALUATE THE RELATIONSHIP OF THE ', 'CORRELATED VARIABLES IN THE MATRIX.' | Fatal error: The input rank correlation matrix is not positive definite.  |
| RDPAR   | 'THE FOLLOWING CARD (POSSIBLY BLANK) IS NOT A ', 'VALID PARAMETER/DATA CARD',/,6X,'PLEASE CONSULT THE ', 'USER MANUAL FOR THE CORRECT PARAMETER/DATA CARD SYNTAX',   | Fatal error: The parameter card is not in a valid form.   |
|         | 'THE FOLLOWING PARAMETER CARD DID NOT HAVE THE ', 'CORRECT DATA CARD ASSOCIATED WITH IT',/,6X,'PLEASE ', 'USER MANUAL FOR THE CORRECT DATA ', 'CARD SYNTAX'  | Fatal error: Incorrect data was assigned with a parameter.  |
|         | 'THE NUMBER OF OBSERVATIONS REQUESTED IS LESS ', 'THAN ONE',   | Fatal error: The number of observations requested is less than one.   |
|         | 'THE NUMBER OF REPETITIONS REQUESTED IS LESS ', 'THAN ONE'   | Fatal error: The number of repetitions requested is less than one.  |
| RIERFC1 | ' Y LESS THAN EXP(-81.) OR Y GREATER THAN 1.0'   | Fatal error: the inverse coerror function used for normal and lognormal distributions is not defined outside of the interval [1e-81,1]. |

---

## 9.0 DESCRIPTION OF THE OUTPUT

The LHS code creates two output files during a run. The first is an ASCII text log file suitable for use as an input file to POSTLHS, and the second is an ASCII text debug file. Both files are described in detail in the paragraphs that follow. Sample listings of the LHS output files are given in Appendix B and Appendix C of this report.

### 9.1 LHS Output Log File

The LHS output log file is an ASCII text file created specifically for use as the input control file to POSTLHS. It contains all the LHS sampling information required by POSTLHS. Appendix B contains a sample output log file.

The first data block of LHS's output log file contains an echoed listing of the LHS input file, rearranged somewhat to be more understandable to the user. Included in the "echoed input" section are the LHS execution keywords, input execution-parameter data specifications, a recapitulation of the input information for the various distributions sampled, and information concerning the correlation matrix.

The next data block of the output log file is a group of tables showing resulting values over all outcomes for each of the distributions sampled. The table heading "RUN NO." identifies the outcome vector number, there being 1 - 75 in the case of the sample problem in Appendix B. The headers "X(1) X(2) X(3) ...X(10)" identify each of the 10 distributions sampled, with the sampled values listed under these headings on a vector by vector basis. For the example in Appendix B, there were 75 outcome vectors and 10 sampled distributions. Since an LHS sample table can contain up to 10 distributions, a single table is sufficient to present the entire sample. The table contains 75 outcome vectors, each containing sampled results for distributions 1 - 10. The information in this table is used as input to POSTLHS.

Once the *raw data* table has been presented, a similar table is written for the ranks of the Latin-hypercube sample values. This table shows the rank of a given distribution's sampled value in comparison to all the other values for that particular distribution over the entire 75-outcome vector sample. For example, in sampled distribution number "X(1)", which is a normal distribution, outcome vector number 57 is ranked first. That means the actual sampled value for outcome vector number 57 of that distribution is the smallest of the entire 75-outcome sample (in this case it is -5.000E-02). At the other end of the spectrum, outcome vector number 15 is the largest value for that distribution (ranked 75th at a value of 2.000E-01). The minimum to maximum range for sample variable number 1 is 5.000E-02 - 2.000E-01. Correlations called for in LHS's input file are implemented on the basis of ranked data rather than raw data.

Since the OUTCOME keyword HIST was specified in the LHS input file, histogram density function plots, together with applicable statistical data, are presented for each of the 10 distributions generated in the example file given in Appendix B. A header at the top of each histogram identifies the distribution being displayed. The graphical plot gives a rough outline of the distribution shape



and shows where the sampled values fall between the function's upper and lower bounds. For density, the distance between the function's bounds is subdivided into segments, and the sampled outcomes are allocated to their associated segment, depending on their value. Statistical data located directly beneath the histogram plots show the actual minimum and maximum values sampled for a given distribution, the mean and median values of the sampled distribution, and the associated variance. These statistical measures can assist users endeavoring to assure that a sampled distribution is correct.

The last data block found on the LHS log output file listed in Appendix B gives correlation tables for the raw sampled data, including ranks. These tables give the correlations between each distribution and all of the other distributions present in the sample. Positive correlations indicate that high values in one variable correlate with high variables in the other. Negative correlations indicate that high values in one variable correlate with low values in the other. The user *should* assure the suitability of the correlations by inspecting the rank-correlation table and determining whether the correlations specified in the LHS input file were implemented. The user *should* scour the entire table for spurious correlations. To accomplish that, users must have prior knowledge of the distributions being generated and their interrelationships.

## 9.2 LHS Output Debug File

The LHS output debug file is a simple free-formatted list containing the raw sampled values for each of the distributions over all of the vector outcomes. The sample file in Appendix C contains raw data for each of the 10 distributions, for each of the 75 outcome vectors. The first number listed is the outcome vector number. It is followed by the number of data entries in the outcome, and then by the sampled data values themselves. The sampled data are listed in the same order in which they were given in the LHS input file. For the sample output debug file in Appendix C, the first outcome vector lists the value 7.3280208E-02 as the value associated with distribution 1. The value of the last (or 10<sup>th</sup>) sampled distribution for outcome vector 1 is 1.8736359E-04. This first distribution is a NORMAL distribution with lower and upper bounds of 5.000E-02 and 0.2000. The tenth distribution is a LOGSTUDENT distribution with lower and upper bounds of 9.550E-07 and 9.525E-03.

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## APPENDIX A: EXAMPLE OF AN LHS INPUT TEXT FILE (LHS2\_T1.INP)

Listed below is an example LHS input control file, as produced by PRELHS, and described in detail in Sec. 7.0.

```
TITLE SDB: wipp::wipp_copy      Calc: PRELHS      Ver: ING6.4   02/13/96 14:31:39
TITLE CMS Test Input File for the LHS Code
NOBS          75
RANDOM SEED    933090934
NORMAL        GLOBAL      DISPPERC
  5.00000E-02  2.00000E-01
LOGNORMAL     COLLOID     CONC
  1.00000E-02  1.00000E+02
UNIFORM       WAS_AREA    TAUFAIL
  4.80000E-02  9.60000E+00
LOGUNIFORM    WAS_AREA    SPPERM
  1.00000E-17  1.00000E-12
USER DISTRIBUTION (CUMULATIVE)  BOREHOLE  DOMEGA
  20          SPECIFIED  CONTINUOUS
  4.20000E+00  0.00000
  4.20000E+00  0.15000
  6.30000E+00  0.00000
  6.30000E+00  0.50000
  8.40000E+00  0.00000
  8.40000E+00  0.15000
  1.05000E+01  0.00000
  1.05000E+01  0.10000
  1.26000E+01  0.00000
  1.26000E+01  0.05000
  1.47000E+01  0.00000
  1.47000E+01  0.02000
  1.68000E+01  0.00000
  1.68000E+01  0.01000
  1.88000E+01  0.00000
  1.88000E+01  0.01000
  2.09000E+01  0.00000
  2.09000E+01  0.01000
  2.30000E+01  0.00000
  2.30000E+01  0.00000
USER DISTRIBUTION (DATA)        CULEBRA  POROSITY
  21          EQUAL  CONTINUOUS
  5.80563E-02  9.55000E-02  1.03330E-01  1.07400E-01  1.15000E-01  1.20500E-01
  1.22250E-01  1.23500E-01  1.29000E-01  1.38500E-01  1.44330E-01  1.46500E-01
  1.61600E-01  1.61800E-01  1.65170E-01  1.78000E-01  1.78400E-01  1.79600E-01
  2.02500E-01  2.07750E-01  2.52500E-01
USER DISTRIBUTION (DELTA)        BOREHOLE  DIAMMOD
  14          SPECIFIED  DISCRETE
  5.08000E-02  0.07143
  1.01600E-01  0.07143
  1.52400E-01  0.07143
  1.93680E-01  0.07143
  2.19080E-01  0.07143
  2.28600E-01  0.07143
  2.50830E-01  0.07143
  2.79400E-01  0.07143
  3.04800E-01  0.07143
  3.49250E-01  0.07143
  3.81000E-01  0.07143
  4.44500E-01  0.07143
  5.58800E-01  0.07143
  6.09600E-01  0.07144
TRIANGULAR    WAS_AREA  GRATCORI
  0.00000E+00  3.20000E-09  6.40000E-07
```

---

| STUDENT     | S_MB139     | POROSITY    |             |             |             |
|-------------|-------------|-------------|-------------|-------------|-------------|
| 16          |             |             |             |             |             |
| 4.00000E-03 | 5.00000E-03 | 5.00000E-03 | 8.00000E-03 | 1.00000E-02 | 1.10000E-02 |
| 1.30000E-02 | 1.30000E-02 | 1.60000E-02 | 1.60000E-02 | 1.60000E-02 | 1.70000E-02 |
| 1.80000E-02 | 1.90000E-02 | 2.10000E-02 | 2.70000E-02 |             |             |

| LOGSTUDENT  | STULMAT1    | STULPRP1    |             |             |             |
|-------------|-------------|-------------|-------------|-------------|-------------|
| 20          |             |             |             |             |             |
| 9.55000E-07 | 1.03330E-06 | 1.57400E-06 | 2.15000E-06 | 4.20500E-06 | 8.22250E-06 |
| 2.23500E-05 | 4.29000E-05 | 7.38500E-05 | 9.44330E-05 | 1.46500E-04 | 3.61600E-04 |
| 5.61800E-04 | 7.65170E-04 | 9.78000E-04 | 1.78400E-03 | 2.79600E-03 | 5.02500E-03 |
| 7.07750E-03 | 9.52500E-03 |             |             |             |             |

CORRELATION MATRIX

|   |   |       |  |  |
|---|---|-------|--|--|
| 4 |   |       |  |  |
| 1 | 3 | 0.999 |  |  |
| 2 | 5 | 0.950 |  |  |
| 4 | 6 | 0.800 |  |  |
| 5 | 2 | 0.950 |  |  |

OUTPUT CORR HIST DATA

TITLE SDB: wipp::wipp\_copy      Calc: PRELHS      Ver: ING6.4      02/13/96 14:31:39

**END OF APPENDIX A**

## APPENDIX B: EXAMPLE OF AN LHS OUTPUT TEXT FILE (LHS2\_T1.OUT)

Listed below is an example LHS ASCII text output log file, as described in detail in Sec. 9.1. This file is suitable in its present form for use as an input file to the POSTLHS code.

```

TITLE SDB: wipp::wipp_copy      Calc: PRELHS      Ver: ING6.4      08/02/96 15:17:16

RANDOM SEED =      933090934

NUMBER OF VARIABLES =      10

NUMBER OF OBSERVATIONS =      75
0 AN INPUT CORRELATION MATRIX HAS BEEN SPECIFIED
0 THE SAMPLE INPUT VECTORS WILL BE PRINTED ALONG WITH THEIR CORRESPONDING RANKS
0 HISTOGRAMS OF THE ACTUAL SAMPLE WILL BE PLOTTED FOR EACH INPUT VARIABLE
0 THE CORRELATION MATRICES (RAW DATA AND RANK CORRELATIONS) WILL BE PRINTED
1

TITLE SDB: wipp::wipp_copy      Calc: PRELHS      Ver: ING6.4      08/02/96 15:17:16

VARIABLE  DISTRIBUTION          RANGE          LABEL
0 1 NORMAL          5.0000E-02 TO 0.2000      GLOBAL      DISPPERC
0 2 LOGNORMAL       1.0000E-02 TO 100.0        COLLOID     CONC
0 3 UNIFORM         4.8000E-02 TO 9.600        WAS_AREA    TAUFAIL
0 4 LOGUNIFORM      1.0000E-17 TO 1.0000E-12  WAS_AREA    SPPERM
0 5 USER SUPPLIED DISTRIBUTION (CUMULATIVE) BOREHOLE DOMEGA
0 6 USER SUPPLIED DISTRIBUTION (DATA)        CULEBRA POROSITY
0 7 USER SUPPLIED DISTRIBUTION (DELTA)        BOREHOLE DIAMMOD
0 8 TRIANGULAR      WITH PARAMETERS BELOW WAS_AREA GRATCORI
      A=      0.0000E+00
      B=      3.2000E-09
      C=      6.4000E-07
0 9 STUDENT         WITH PARAMETERS BELOW S_MB139 POROSITY
      15 DEGREES OF FREEDOM
      AVG=     1.3688E-02
      STDDEV=  1.5857E-03
0 10 LOGSTUDENT     WITH PARAMETERS BELOW STULMAT1 STULPRP1
      19 DEGREES OF FREEDOM
      LOG AVG= -9.157
      LOG STDDEV= 0.6912      1TITLE SDB: wipp::wipp_copy      Calc:
PRELHS      Ver: ING6.4      08/02/96 15:17:16
0INPUT RANK CORRELATION MATRIX.
PAGE      1
0 1 1.0000
0 2 0.0000 1.0000
0 3 0.9990 0.0000 1.0000
0 4 0.0000 0.0000 0.0000 1.0000
0 5 0.0000 0.9500 0.0000 0.0000 1.0000
0 6 0.0000 0.0000 0.0000 0.8000 0.0000 1.0000
0      1      2      3      4      5      6
0VARIABLES
1TITLE SDB: wipp::wipp_copy      Calc: PRELHS      Ver: ING6.4      08/02/96 15:17:16
0LATIN HYPERCUBE SAMPLE INPUT VECTORS

RUN NO.  X(1)      X(2)      X(3)      X(4)      X(5)      X(6)      X(7)
X(8)      X(9)      X(10)
0 1 7.328E-02 6.363E+01 5.965E-01 1.923E-15 1.726E+01 1.223E-01 4.445E-01
2.629E-09 1.235E-02 1.874E-04
0 2 1.513E-01 7.549E-01 7.622E+00 2.151E-17 7.654E+00 9.729E-02 1.016E-01
8.057E-08 1.375E-02 8.714E-05

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|           |    |           |           |           |           |           |           |           |
|-----------|----|-----------|-----------|-----------|-----------|-----------|-----------|-----------|
| 0         | 3  | 1.548E-01 | 1.292E+00 | 8.060E+00 | 1.412E-15 | 8.131E+00 | 1.203E-01 | 2.191E-01 |
| 5.673E-07 |    | 1.260E-02 | 1.742E-04 |           |           |           |           |           |
| 0         | 4  | 9.847E-02 | 1.365E+00 | 1.950E+00 | 1.881E-13 | 9.075E+00 | 2.048E-01 | 1.937E-01 |
| 3.641E-07 |    | 1.341E-02 | 2.744E-04 |           |           |           |           |           |
| 0         | 5  | 1.272E-01 | 3.940E+00 | 4.973E+00 | 4.368E-16 | 1.033E+01 | 9.193E-02 | 3.810E-01 |
| 1.809E-07 |    | 1.411E-02 | 7.108E-05 |           |           |           |           |           |
| 0         | 6  | 1.394E-01 | 3.218E-01 | 6.417E+00 | 1.288E-17 | 6.066E+00 | 7.738E-02 | 3.492E-01 |
| 1.863E-07 |    | 1.328E-02 | 1.841E-04 |           |           |           |           |           |
| 0         | 7  | 1.139E-01 | 8.697E-01 | 3.595E+00 | 9.036E-16 | 7.449E+00 | 1.641E-01 | 5.588E-01 |
| 2.344E-07 |    | 1.362E-02 | 7.714E-05 |           |           |           |           |           |
| 0         | 8  | 1.433E-01 | 1.975E+00 | 6.764E+00 | 8.606E-13 | 8.173E+00 | 2.311E-01 | 2.191E-01 |
| 1.718E-07 |    | 1.197E-02 | 4.134E-05 |           |           |           |           |           |
| 0         | 9  | 1.003E-01 | 2.068E-01 | 2.163E+00 | 5.227E-16 | 6.905E+00 | 1.185E-01 | 4.445E-01 |
| 4.915E-07 |    | 1.367E-02 | 6.875E-05 |           |           |           |           |           |
| 0         | 10 | 9.127E-02 | 1.777E-01 | 1.542E+00 | 5.768E-13 | 5.687E+00 | 1.653E-01 | 1.016E-01 |
| 3.392E-07 |    | 1.158E-02 | 6.490E-05 |           |           |           |           |           |
| 0         | 11 | 1.788E-01 | 2.063E+00 | 9.130E+00 | 2.381E-14 | 8.361E+00 | 1.633E-01 | 2.508E-01 |
| 1.223E-07 |    | 1.445E-02 | 2.476E-04 |           |           |           |           |           |
| 0         | 12 | 1.450E-01 | 5.165E+00 | 7.247E+00 | 2.650E-13 | 1.110E+01 | 1.535E-01 | 1.016E-01 |
| 8.441E-09 |    | 1.309E-02 | 5.240E-04 |           |           |           |           |           |
| 0         | 13 | 1.381E-01 | 5.735E-01 | 6.365E+00 | 4.207E-15 | 8.344E+00 | 1.311E-01 | 2.794E-01 |
| 3.019E-07 |    | 1.243E-02 | 4.912E-05 |           |           |           |           |           |
| 0         | 14 | 1.421E-01 | 1.041E+00 | 6.882E+00 | 7.603E-15 | 7.933E+00 | 1.232E-01 | 3.048E-01 |
| 4.136E-07 |    | 1.215E-02 | 9.461E-05 |           |           |           |           |           |
| 0         | 15 | 2.000E-01 | 7.332E-01 | 9.514E+00 | 4.210E-14 | 7.866E+00 | 1.788E-01 | 5.588E-01 |
| 1.283E-07 |    | 1.304E-02 | 1.288E-04 |           |           |           |           |           |
| 0         | 16 | 1.344E-01 | 3.026E+00 | 5.901E+00 | 1.112E-14 | 9.321E+00 | 1.446E-01 | 1.016E-01 |
| 7.644E-08 |    | 1.724E-02 | 9.964E-05 |           |           |           |           |           |
| 0         | 17 | 1.051E-01 | 3.152E-01 | 2.939E+00 | 2.967E-16 | 6.434E+00 | 1.709E-01 | 1.016E-01 |
| 4.222E-07 |    | 1.395E-02 | 3.198E-04 |           |           |           |           |           |
| 0         | 18 | 1.479E-01 | 2.132E-01 | 7.354E+00 | 8.350E-13 | 6.323E+00 | 1.792E-01 | 3.492E-01 |
| 2.825E-07 |    | 1.595E-02 | 1.922E-04 |           |           |           |           |           |
| 0         | 19 | 1.648E-01 | 1.220E+00 | 8.615E+00 | 3.386E-14 | 7.490E+00 | 1.371E-01 | 1.524E-01 |
| 4.815E-08 |    | 1.405E-02 | 1.316E-04 |           |           |           |           |           |
| 0         | 20 | 1.126E-01 | 7.694E+00 | 3.307E+00 | 5.245E-15 | 1.238E+01 | 1.619E-01 | 5.080E-02 |
| 3.032E-07 |    | 1.207E-02 | 9.045E-05 |           |           |           |           |           |
| 0         | 21 | 9.753E-02 | 6.905E-01 | 1.961E+00 | 1.109E-13 | 7.854E+00 | 2.028E-01 | 3.810E-01 |
| 7.095E-08 |    | 1.642E-02 | 1.661E-04 |           |           |           |           |           |
| 0         | 22 | 1.256E-01 | 9.872E-01 | 4.839E+00 | 2.600E-15 | 8.299E+00 | 1.397E-01 | 2.508E-01 |
| 3.960E-07 |    | 1.138E-02 | 1.985E-04 |           |           |           |           |           |
| 0         | 23 | 1.401E-01 | 4.778E-02 | 6.546E+00 | 1.465E-16 | 6.495E+00 | 1.214E-01 | 4.445E-01 |
| 3.178E-07 |    | 1.693E-02 | 2.372E-04 |           |           |           |           |           |
| 0         | 24 | 1.751E-01 | 2.691E+01 | 9.027E+00 | 7.047E-16 | 1.404E+01 | 1.617E-01 | 2.508E-01 |
| 3.551E-08 |    | 1.108E-02 | 6.078E-05 |           |           |           |           |           |
| 0         | 25 | 9.516E-02 | 1.576E-01 | 1.739E+00 | 1.761E-16 | 6.619E+00 | 1.049E-01 | 1.937E-01 |
| 4.600E-07 |    | 1.163E-02 | 1.031E-04 |           |           |           |           |           |
| 0         | 26 | 1.012E-01 | 2.679E-01 | 2.374E+00 | 8.854E-14 | 6.690E+00 | 1.787E-01 | 2.794E-01 |
| 2.864E-08 |    | 1.561E-02 | 1.720E-04 |           |           |           |           |           |
| 0         | 27 | 1.847E-01 | 4.285E-01 | 9.235E+00 | 1.308E-16 | 6.884E+00 | 1.622E-01 | 2.286E-01 |
| 1.540E-07 |    | 1.294E-02 | 1.630E-04 |           |           |           |           |           |
| 0         | 28 | 1.228E-01 | 1.000E+02 | 4.418E+00 | 2.514E-16 | 1.862E+01 | 1.440E-01 | 6.096E-01 |
| 5.525E-07 |    | 1.519E-02 | 1.255E-04 |           |           |           |           |           |
| 0         | 29 | 1.169E-01 | 8.488E-02 | 3.951E+00 | 6.471E-15 | 5.281E+00 | 1.326E-01 | 1.016E-01 |
| 1.059E-07 |    | 1.436E-02 | 9.560E-05 |           |           |           |           |           |
| 0         | 30 | 1.165E-01 | 3.573E+00 | 3.424E+00 | 7.758E-14 | 7.538E+00 | 2.063E-01 | 4.445E-01 |
| 5.622E-08 |    | 1.352E-02 | 2.180E-04 |           |           |           |           |           |
| 0         | 31 | 1.281E-01 | 2.871E+00 | 5.194E+00 | 4.117E-13 | 9.641E+00 | 1.917E-01 | 6.096E-01 |
| 1.298E-07 |    | 1.248E-02 | 1.490E-04 |           |           |           |           |           |
| 0         | 32 | 1.100E-01 | 3.781E-01 | 3.029E+00 | 1.561E-14 | 7.686E+00 | 1.617E-01 | 2.286E-01 |
| 3.469E-07 |    | 1.524E-02 | 2.959E-04 |           |           |           |           |           |
| 0         | 33 | 1.605E-01 | 1.763E-02 | 8.309E+00 | 2.222E-16 | 4.943E+00 | 1.225E-01 | 6.096E-01 |
| 1.359E-07 |    | 1.429E-02 | 6.283E-05 |           |           |           |           |           |
| 0         | 34 | 8.529E-02 | 1.858E+01 | 1.164E+00 | 1.307E-15 | 2.253E+01 | 1.559E-01 | 3.048E-01 |
| 3.350E-07 |    | 1.565E-02 | 5.169E-05 |           |           |           |           |           |

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|           |           |           |           |           |           |           |           |           |
|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|
| 0         | 35        | 1.122E-01 | 2.813E-01 | 3.703E+00 | 6.329E-17 | 7.078E+00 | 1.252E-01 | 3.492E-01 |
| 6.236E-08 | 1.288E-02 | 3.772E-04 |           |           |           |           |           |           |
| 0         | 36        | 1.708E-01 | 6.707E+00 | 8.869E+00 | 2.567E-17 | 1.179E+01 | 1.038E-01 | 5.588E-01 |
| 2.387E-07 | 1.321E-02 | 1.029E-05 |           |           |           |           |           |           |
| 0         | 37        | 6.799E-02 | 2.482E+00 | 3.735E-01 | 1.079E-15 | 8.617E+00 | 1.953E-01 | 3.492E-01 |
| 1.135E-07 | 1.379E-02 | 1.067E-04 |           |           |           |           |           |           |
| 0         | 38        | 1.338E-01 | 6.294E+00 | 6.014E+00 | 1.593E-17 | 1.207E+01 | 1.091E-01 | 2.286E-01 |
| 1.141E-07 | 1.550E-02 | 4.357E-05 |           |           |           |           |           |           |
| 0         | 39        | 1.462E-01 | 4.445E+00 | 7.152E+00 | 3.866E-15 | 1.030E+01 | 1.464E-01 | 3.492E-01 |
| 2.484E-08 | 9.949E-03 | 1.422E-04 |           |           |           |           |           |           |
| 0         | 40        | 1.659E-01 | 1.340E-01 | 8.581E+00 | 2.106E-14 | 5.039E+00 | 1.783E-01 | 4.445E-01 |
| 2.737E-07 | 1.281E-02 | 8.556E-05 |           |           |           |           |           |           |
| 0         | 41        | 8.186E-02 | 1.310E+01 | 8.700E-01 | 5.577E-16 | 1.147E+01 | 1.410E-01 | 1.937E-01 |
| 9.889E-08 | 1.360E-02 | 7.847E-05 |           |           |           |           |           |           |
| 0         | 42        | 1.365E-01 | 1.511E+00 | 6.112E+00 | 2.744E-14 | 9.846E+00 | 1.752E-01 | 1.524E-01 |
| 2.566E-07 | 1.478E-02 | 1.376E-04 |           |           |           |           |           |           |
| 0         | 43        | 1.031E-01 | 3.131E-02 | 2.331E+00 | 4.156E-17 | 4.264E+00 | 1.289E-01 | 2.794E-01 |
| 2.708E-07 | 1.402E-02 | 1.343E-04 |           |           |           |           |           |           |
| 0         | 44        | 1.327E-01 | 2.214E+00 | 5.408E+00 | 1.341E-13 | 8.653E+00 | 1.455E-01 | 1.937E-01 |
| 6.645E-08 | 1.130E-02 | 9.126E-05 |           |           |           |           |           |           |
| 0         | 45        | 8.291E-02 | 5.315E-01 | 1.012E+00 | 2.416E-15 | 7.149E+00 | 1.136E-01 | 2.286E-01 |
| 1.859E-08 | 1.440E-02 | 2.941E-05 |           |           |           |           |           |           |
| 0         | 46        | 9.012E-02 | 6.120E-01 | 1.198E+00 | 1.803E-13 | 7.212E+00 | 1.783E-01 | 5.080E-02 |
| 2.476E-07 | 1.459E-02 | 5.364E-05 |           |           |           |           |           |           |
| 0         | 47        | 1.465E-01 | 2.335E-01 | 6.928E+00 | 2.033E-16 | 6.844E+00 | 9.960E-02 | 5.588E-01 |
| 2.077E-07 | 1.540E-02 | 1.174E-04 |           |           |           |           |           |           |
| 0         | 48        | 1.564E-01 | 1.478E-01 | 7.887E+00 | 3.799E-14 | 6.373E+00 | 1.781E-01 | 3.048E-01 |
| 2.601E-07 | 1.467E-02 | 6.619E-05 |           |           |           |           |           |           |
| 0         | 49        | 1.579E-01 | 8.908E-02 | 8.081E+00 | 3.579E-13 | 5.725E+00 | 1.866E-01 | 1.937E-01 |
| 3.797E-08 | 1.577E-02 | 1.555E-04 |           |           |           |           |           |           |
| 0         | 50        | 1.080E-01 | 1.179E-02 | 2.618E+00 | 3.257E-17 | 4.469E+00 | 1.061E-01 | 1.524E-01 |
| 4.489E-08 | 9.006E-03 | 1.507E-04 |           |           |           |           |           |           |
| 0         | 51        | 1.148E-01 | 5.629E+00 | 3.837E+00 | 5.699E-17 | 9.443E+00 | 1.084E-01 | 2.508E-01 |
| 3.709E-07 | 1.350E-02 | 2.558E-05 |           |           |           |           |           |           |
| 0         | 52        | 1.094E-01 | 4.127E-01 | 3.228E+00 | 5.136E-13 | 6.669E+00 | 2.483E-01 | 2.508E-01 |
| 8.724E-08 | 1.453E-02 | 8.363E-05 |           |           |           |           |           |           |
| 0         | 53        | 1.242E-01 | 1.449E+01 | 4.662E+00 | 1.076E-17 | 1.053E+01 | 5.871E-02 | 2.191E-01 |
| 9.657E-08 | 1.487E-02 | 3.914E-04 |           |           |           |           |           |           |
| 0         | 54        | 1.368E-01 | 8.148E-01 | 6.241E+00 | 1.029E-16 | 7.054E+00 | 1.219E-01 | 1.524E-01 |
| 9.267E-08 | 1.780E-02 | 8.084E-05 |           |           |           |           |           |           |
| 0         | 55        | 1.181E-01 | 2.590E-02 | 4.318E+00 | 7.707E-17 | 4.680E+00 | 1.773E-01 | 3.492E-01 |
| 1.495E-07 | 1.083E-02 | 1.105E-04 |           |           |           |           |           |           |
| 0         | 56        | 7.126E-02 | 2.160E+01 | 5.453E-01 | 1.652E-14 | 1.250E+01 | 1.126E-01 | 6.096E-01 |
| 4.458E-07 | 1.385E-02 | 8.890E-04 |           |           |           |           |           |           |
| 0         | 57        | 5.000E-02 | 4.771E-01 | 1.035E-01 | 3.896E-17 | 6.983E+00 | 1.177E-01 | 2.286E-01 |
| 2.279E-07 | 1.190E-02 | 5.691E-05 |           |           |           |           |           |           |
| 0         | 58        | 1.064E-01 | 1.010E+01 | 2.806E+00 | 3.814E-16 | 1.004E+01 | 1.238E-01 | 6.096E-01 |
| 1.571E-07 | 1.503E-02 | 1.202E-04 |           |           |           |           |           |           |
| 0         | 59        | 1.320E-01 | 1.641E+00 | 5.574E+00 | 5.846E-15 | 8.932E+00 | 1.231E-01 | 4.445E-01 |
| 2.280E-08 | 1.179E-02 | 4.712E-05 |           |           |           |           |           |           |
| 0         | 60        | 7.722E-02 | 2.580E+00 | 7.965E-01 | 7.787E-16 | 8.246E+00 | 1.209E-01 | 4.445E-01 |
| 1.751E-07 | 1.388E-02 | 1.134E-04 |           |           |           |           |           |           |
| 0         | 61        | 1.220E-01 | 1.801E+00 | 4.516E+00 | 1.708E-15 | 7.755E+00 | 1.460E-01 | 1.937E-01 |
| 4.409E-07 | 1.055E-02 | 1.085E-04 |           |           |           |           |           |           |
| 0         | 62        | 1.250E-01 | 5.108E-01 | 5.054E+00 | 6.536E-13 | 7.273E+00 | 1.795E-01 | 3.810E-01 |
| 3.926E-07 | 1.427E-02 | 3.705E-05 |           |           |           |           |           |           |
| 0         | 63        | 5.678E-02 | 6.967E-02 | 2.050E-01 | 6.213E-14 | 6.521E+00 | 1.433E-01 | 3.810E-01 |
| 1.193E-08 | 1.473E-02 | 5.481E-05 |           |           |           |           |           |           |
| 0         | 64        | 8.768E-02 | 9.451E-01 | 1.369E+00 | 1.504E-13 | 7.591E+00 | 2.075E-01 | 2.191E-01 |
| 3.764E-07 | 1.607E-02 | 5.880E-05 |           |           |           |           |           |           |
| 0         | 65        | 1.694E-01 | 4.333E+01 | 8.733E+00 | 1.214E-14 | 1.383E+01 | 1.698E-01 | 2.794E-01 |
| 1.412E-07 | 1.492E-02 | 4.028E-05 |           |           |           |           |           |           |
| 0         | 66        | 1.041E-01 | 3.279E+00 | 2.537E+00 | 2.243E-17 | 8.047E+00 | 1.009E-01 | 5.080E-02 |
| 2.157E-07 | 1.420E-02 | 7.534E-05 |           |           |           |           |           |           |



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0 67 1.883E-01 1.764E+00 9.386E+00 8.626E-17 8.021E+00 1.153E-01 1.524E-01
5.089E-07 1.507E-02 2.257E-04
0 68 1.207E-01 1.083E-01 4.134E+00 1.441E-17 6.770E+00 8.579E-02 2.794E-01
5.100E-08 1.268E-02 9.817E-05
0 69 1.291E-01 5.560E-02 5.344E+00 3.404E-15 5.353E+00 1.261E-01 3.048E-01
1.623E-07 1.312E-02 2.232E-05
0 70 1.191E-01 1.241E-01 4.095E+00 5.381E-14 6.089E+00 1.617E-01 6.096E-01
2.914E-07 1.266E-02 2.595E-04
0 71 1.307E-01 1.124E+00 5.753E+00 3.323E-13 7.373E+00 1.596E-01 2.286E-01
5.354E-07 1.278E-02 7.279E-05
0 72 1.528E-01 3.562E-01 7.790E+00 5.164E-17 7.307E+00 1.051E-01 5.080E-02
3.216E-07 1.635E-02 3.434E-05
0 73 9.371E-02 1.107E+01 1.670E+00 2.411E-13 1.456E+01 2.035E-01 3.048E-01
2.037E-07 1.334E-02 1.147E-04
0 74 1.493E-01 8.812E+00 7.455E+00 9.780E-15 1.306E+01 1.355E-01 5.080E-02
1.976E-07 1.225E-02 2.096E-04
0 75 1.617E-01 4.291E+00 8.404E+00 6.583E-14 1.093E+01 2.178E-01 2.508E-01
2.225E-07 1.324E-02 1.446E-04
  
```

ITITLE SDB: wipp:wipp\_copy Calc: PRELHS Ver: ING6.4 08/02/96 15:17:16  
 ORANKS OF LATIN HYPERCUBE SAMPLE INPUT VECTORS

| RUN NO. | X(1) | X(2) | X(3) | X(4) | X(5) | X(6) | X(7) |
|---------|------|------|------|------|------|------|------|
| 0       | 1    | 5.   | 74.  | 5.   | 35.  | 73.  | 23.  |
| 1.      | 16.  | 60.  |      |      |      |      | 62.  |
| 0       | 2    | 60.  | 34.  | 60.  | 5.   | 36.  | 5.   |
| 18.     | 39.  | 30.  |      |      |      |      | 9.   |
| 0       | 3    | 62.  | 42.  | 63.  | 33.  | 44.  | 19.  |
| 75.     | 19.  | 58.  |      |      |      |      | 25.  |
| 0       | 4    | 16.  | 43.  | 15.  | 65.  | 53.  | 70.  |
| 61.     | 33.  | 69.  |      |      |      |      | 20.  |
| 0       | 5    | 40.  | 57.  | 39.  | 25.  | 60.  | 4.   |
| 37.     | 46.  | 22.  |      |      |      |      | 57.  |
| 0       | 6    | 51.  | 22.  | 51.  | 2.   | 10.  | 2.   |
| 38.     | 31.  | 59.  |      |      |      |      | 52.  |
| 0       | 7    | 28.  | 36.  | 28.  | 30.  | 32.  | 52.  |
| 45.     | 37.  | 25.  |      |      |      |      | 68.  |
| 0       | 8    | 54.  | 48.  | 53.  | 75.  | 45.  | 74.  |
| 35.     | 12.  | 8.   |      |      |      |      | 25.  |
| 0       | 9    | 17.  | 16.  | 17.  | 26.  | 23.  | 18.  |
| 71.     | 38.  | 21.  |      |      |      |      | 62.  |
| 0       | 10   | 12.  | 15.  | 12.  | 72.  | 8.   | 53.  |
| 59.     | 8.   | 19.  |      |      |      |      | 9.   |
| 0       | 11   | 72.  | 49.  | 72.  | 51.  | 49.  | 51.  |
| 26.     | 52.  | 67.  |      |      |      |      | 36.  |
| 0       | 12   | 55.  | 60.  | 57.  | 67.  | 63.  | 43.  |
| 2.      | 27.  | 74.  |      |      |      |      | 9.   |
| 0       | 13   | 50.  | 30.  | 50.  | 40.  | 48.  | 31.  |
| 54.     | 17.  | 11.  |      |      |      |      | 41.  |
| 0       | 14   | 53.  | 39.  | 54.  | 44.  | 41.  | 26.  |
| 66.     | 14.  | 33.  |      |      |      |      | 46.  |
| 0       | 15   | 75.  | 33.  | 75.  | 55.  | 40.  | 62.  |
| 27.     | 26.  | 46.  |      |      |      |      | 68.  |
| 0       | 16   | 47.  | 54.  | 46.  | 46.  | 54.  | 39.  |
| 17.     | 74.  | 36.  |      |      |      |      | 9.   |
| 0       | 17   | 21.  | 21.  | 23.  | 23.  | 14.  | 55.  |
| 67.     | 43.  | 71.  |      |      |      |      | 9.   |
| 0       | 18   | 58.  | 17.  | 58.  | 74.  | 12.  | 63.  |
| 52.     | 69.  | 61.  |      |      |      |      | 52.  |
| 0       | 19   | 67.  | 41.  | 68.  | 53.  | 33.  | 34.  |
| 11.     | 45.  | 47.  |      |      |      |      | 14.  |
| 0       | 20   | 27.  | 64.  | 26.  | 41.  | 67.  | 49.  |
| 55.     | 13.  | 31.  |      |      |      |      | 3.   |

|     |    |     |     |     |     |     |     |     |
|-----|----|-----|-----|-----|-----|-----|-----|-----|
| 0   | 21 | 15. | 32. | 16. | 61. | 39. | 68. | 57. |
| 16. |    | 72. | 56. |     |     |     |     |     |
| 0   | 22 | 39. | 38. | 38. | 37. | 47. | 35. | 36. |
| 65. |    | 7.  | 62. |     |     |     |     |     |
| 0   | 23 | 52. | 5.  | 52. | 18. | 15. | 21. | 62. |
| 56. |    | 73. | 66. |     |     |     |     |     |
| 0   | 24 | 71. | 72. | 71. | 28. | 71. | 46. | 36. |
| 8.  |    | 5.  | 17. |     |     |     |     |     |
| 0   | 25 | 14. | 14. | 14. | 19. | 17. | 9.  | 20. |
| 70. |    | 9.  | 37. |     |     |     |     |     |
| 0   | 26 | 18. | 19. | 19. | 60. | 19. | 61. | 41. |
| 7.  |    | 66. | 57. |     |     |     |     |     |
| 0   | 27 | 73. | 26. | 73. | 17. | 22. | 50. | 30. |
| 32. |    | 25. | 55. |     |     |     |     |     |
| 0   | 28 | 36. | 75. | 35. | 22. | 74. | 38. | 73. |
| 74. |    | 62. | 45. |     |     |     |     |     |
| 0   | 29 | 31. | 8.  | 31. | 43. | 6.  | 32. | 9.  |
| 23. |    | 50. | 34. |     |     |     |     |     |
| 0   | 30 | 30. | 56. | 27. | 59. | 34. | 71. | 62. |
| 13. |    | 35. | 64. |     |     |     |     |     |
| 0   | 31 | 41. | 53. | 41. | 70. | 56. | 66. | 73. |
| 28. |    | 18. | 52. |     |     |     |     |     |
| 0   | 32 | 25. | 24. | 24. | 48. | 37. | 47. | 30. |
| 60. |    | 63. | 70. |     |     |     |     |     |
| 0   | 33 | 65. | 2.  | 65. | 21. | 4.  | 24. | 73. |
| 29. |    | 49. | 18. |     |     |     |     |     |
| 0   | 34 | 9.  | 70. | 9.  | 32. | 75. | 44. | 46. |
| 58. |    | 67. | 12. |     |     |     |     |     |
| 0   | 35 | 26. | 20. | 29. | 13. | 26. | 28. | 52. |
| 14. |    | 24. | 72. |     |     |     |     |     |
| 0   | 36 | 70. | 63. | 70. | 7.  | 65. | 8.  | 68. |
| 46. |    | 29. | 1.  |     |     |     |     |     |
| 0   | 37 | 3.  | 51. | 3.  | 31. | 50. | 67. | 52. |
| 24. |    | 40. | 38. |     |     |     |     |     |
| 0   | 38 | 46. | 62. | 47. | 4.  | 66. | 13. | 30. |
| 25. |    | 65. | 9.  |     |     |     |     |     |
| 0   | 39 | 56. | 59. | 56. | 39. | 59. | 42. | 52. |
| 6.  |    | 2.  | 50. |     |     |     |     |     |
| 0   | 40 | 68. | 12. | 67. | 50. | 5.  | 59. | 62. |
| 51. |    | 23. | 29. |     |     |     |     |     |
| 0   | 41 | 7.  | 68. | 7.  | 27. | 64. | 36. | 20. |
| 22. |    | 36. | 26. |     |     |     |     |     |
| 0   | 42 | 48. | 44. | 48. | 52. | 57. | 56. | 14. |
| 48. |    | 57. | 49. |     |     |     |     |     |
| 0   | 43 | 19. | 4.  | 18. | 10. | 1.  | 30. | 41. |
| 50. |    | 44. | 48. |     |     |     |     |     |
| 0   | 44 | 45. | 50. | 43. | 62. | 51. | 40. | 20. |
| 15. |    | 6.  | 32. |     |     |     |     |     |
| 0   | 45 | 8.  | 29. | 8.  | 36. | 27. | 15. | 30. |
| 4.  |    | 51. | 4.  |     |     |     |     |     |
| 0   | 46 | 11. | 31. | 10. | 64. | 28. | 60. | 3.  |
| 47. |    | 54. | 13. |     |     |     |     |     |
| 0   | 47 | 57. | 18. | 55. | 20. | 21. | 6.  | 68. |
| 41. |    | 64. | 43. |     |     |     |     |     |
| 0   | 48 | 63. | 13. | 62. | 54. | 13. | 58. | 46. |
| 49. |    | 55. | 20. |     |     |     |     |     |
| 0   | 49 | 64. | 9.  | 64. | 69. | 9.  | 65. | 20. |
| 9.  |    | 68. | 54. |     |     |     |     |     |
| 0   | 50 | 23. | 1.  | 21. | 8.  | 2.  | 11. | 14. |
| 10. |    | 1.  | 53. |     |     |     |     |     |
| 0   | 51 | 29. | 61. | 30. | 12. | 55. | 12. | 36. |
| 62. |    | 34. | 3.  |     |     |     |     |     |
| 0   | 52 | 24. | 25. | 25. | 71. | 18. | 75. | 36. |
| 19. |    | 53. | 28. |     |     |     |     |     |

|     |    |     |     |     |     |     |     |     |
|-----|----|-----|-----|-----|-----|-----|-----|-----|
| 0   | 53 | 37. | 69. | 37. | 1.  | 61. | 1.  | 25. |
| 21. |    | 58. | 73. |     |     |     |     |     |
| 0   | 54 | 49. | 35. | 49. | 16. | 25. | 22. | 14. |
| 20. |    | 75. | 27. |     |     |     |     |     |
| 0   | 55 | 32. | 3.  | 34. | 14. | 3.  | 57. | 52. |
| 31. |    | 4.  | 40. |     |     |     |     |     |
| 0   | 56 | 4.  | 71. | 4.  | 49. | 68. | 14. | 73. |
| 69. |    | 41. | 75. |     |     |     |     |     |
| 0   | 57 | 1.  | 27. | 1.  | 9.  | 24. | 17. | 30. |
| 44. |    | 11. | 15. |     |     |     |     |     |
| 0   | 58 | 22. | 66. | 22. | 24. | 58. | 27. | 73. |
| 33. |    | 60. | 44. |     |     |     |     |     |
| 0   | 59 | 44. | 45. | 44. | 42. | 52. | 25. | 62. |
| 5.  |    | 10. | 10. |     |     |     |     |     |
| 0   | 60 | 6.  | 52. | 6.  | 29. | 46. | 20. | 62. |
| 36. |    | 42. | 41. |     |     |     |     |     |
| 0   | 61 | 35. | 47. | 36. | 34. | 38. | 41. | 20. |
| 68. |    | 3.  | 39. |     |     |     |     |     |
| 0   | 62 | 38. | 28. | 40. | 73. | 29. | 64. | 57. |
| 64. |    | 48. | 6.  |     |     |     |     |     |
| 0   | 63 | 2.  | 7.  | 2.  | 57. | 16. | 37. | 57. |
| 3.  |    | 56. | 14. |     |     |     |     |     |
| 0   | 64 | 10. | 37. | 11. | 63. | 35. | 72. | 25. |
| 63. |    | 70. | 16. |     |     |     |     |     |
| 0   | 65 | 69. | 73. | 69. | 47. | 70. | 54. | 41. |
| 30. |    | 59. | 7.  |     |     |     |     |     |
| 0   | 66 | 20. | 55. | 20. | 6.  | 43. | 7.  | 3.  |
| 42. |    | 47. | 24. |     |     |     |     |     |
| 0   | 67 | 74. | 46. | 74. | 15. | 42. | 16. | 14. |
| 72. |    | 61. | 65. |     |     |     |     |     |
| 0   | 68 | 34. | 10. | 33. | 3.  | 20. | 3.  | 41. |
| 12. |    | 21. | 35. |     |     |     |     |     |
| 0   | 69 | 42. | 6.  | 42. | 38. | 7.  | 29. | 46. |
| 34. |    | 28. | 2.  |     |     |     |     |     |
| 0   | 70 | 33. | 11. | 32. | 56. | 11. | 48. | 73. |
| 53. |    | 20. | 68. |     |     |     |     |     |
| 0   | 71 | 43. | 40. | 45. | 68. | 31. | 45. | 30. |
| 73. |    | 22. | 23. |     |     |     |     |     |
| 0   | 72 | 61. | 23. | 61. | 11. | 30. | 10. | 3.  |
| 57. |    | 71. | 5.  |     |     |     |     |     |
| 0   | 73 | 13. | 67. | 13. | 66. | 72. | 69. | 46. |
| 40. |    | 32. | 42. |     |     |     |     |     |
| 0   | 74 | 59. | 65. | 59. | 45. | 69. | 33. | 3.  |
| 39. |    | 15. | 63. |     |     |     |     |     |
| 0   | 75 | 66. | 58. | 66. | 58. | 62. | 73. | 36. |
| 43. |    | 30. | 51. |     |     |     |     |     |

1 TITLE SDB: wipp::wipp\_copy Calc: PRELHS Ver: ING6.4 08/02/96 15:17:16  
 0 HISTOGRAM FOR VARIABLE NO. 1 NORMAL DISTRIBUTION

| MIDPOINT      | FREQ. |         |
|---------------|-------|---------|
| 0.4874997E-01 | 1     | X       |
| 0.5624997E-01 | 1     | X       |
| 0.6374996E-01 | 0     |         |
| 0.7124995E-01 | 3     | XXX     |
| 0.7874995E-01 | 2     | XX      |
| 0.8624994E-01 | 3     | XXX     |
| 0.9374993E-01 | 4     | XXXX    |
| 0.1012499     | 6     | XXXXXX  |
| 0.1087499     | 6     | XXXXXX  |
| 0.1162499     | 7     | XXXXXXX |
| 0.1237499     | 7     | XXXXXXX |
| 0.1312499     | 7     | XXXXXXX |
| 0.1387499     | 6     | XXXXXX  |
| 0.1462499     | 6     | XXXXXX  |

---

|           |    |      |
|-----------|----|------|
| 0.1537499 | 4  | XXXX |
| 0.1612499 | 4  | XXXX |
| 0.1687499 | 3  | XXX  |
| 0.1762499 | 2  | XX   |
| 0.1837499 | 1  | X    |
| 0.1912498 | 1  | X    |
| 0.1987498 | 1  | X    |
| 0         | 75 |      |

| MIN           | MAX       | RANGE     | MEAN      | MEDIAN    | VARIANCE      |
|---------------|-----------|-----------|-----------|-----------|---------------|
| 0.4999998E-01 | 0.2000000 | 0.1500000 | 0.1248673 | 0.1250420 | 0.1003930E-02 |

1 TITLE SDB: wipp::wipp\_copy Calc: PRELHS Ver: ING6.4 08/02/96 15:17:16  
 0 HISTOGRAM FOR VARIABLE NO. 2 LOGNORMAL DISTRIBUTION

| MIDPOINT | FREQ. |  |
|----------|-------|--|
| 2.499999 | 59    | XX |
| 7.499997 | 6     | XXXXXX   |
| 12.50000 | 4     | XXXX   |
| 17.49999 | 1     | X  |
| 22.49999 | 1     | X  |
| 27.49999 | 1     | X  |
| 32.49999 | 0     |  |
| 37.49999 | 0     |  |
| 42.49999 | 1     | X  |
| 47.49999 | 0     |  |
| 52.49999 | 0     |  |
| 57.49999 | 0     |  |
| 62.49999 | 1     | X  |
| 67.49998 | 0     |  |
| 72.49998 | 0     |  |
| 77.49998 | 0     |  |
| 82.49998 | 0     |  |
| 87.49998 | 0     |  |
| 92.49998 | 0     |  |
| 97.49998 | 0     |  |
| 102.5000 | 1     | X  |
| 0        | 75    |  |

| MIN           | MAX      | RANGE    | MEAN     | MEDIAN    | VARIANCE |
|---------------|----------|----------|----------|-----------|----------|
| 0.1179351E-01 | 100.0001 | 99.98830 | 5.677361 | 0.9872297 | 214.3602 |

1 TITLE SDB: wipp:wipp\_copy Calc: PRELHS Ver: ING6.4 08/02/96 15:17:16  
 0 HISTOGRAM FOR VARIABLE NO. 3 UNIFORM DISTRIBUTION

| MIDPOINT  | FREQ. |       |
|-----------|-------|-------|
| 0.2349999 | 3     | XXX   |
| 0.7049998 | 4     | XXXX  |
| 1.175000  | 4     | XXXX  |
| 1.645000  | 3     | XXX   |
| 2.115000  | 4     | XXXX  |
| 2.584999  | 4     | XXXX  |
| 3.054999  | 3     | XXX   |
| 3.524999  | 4     | XXXX  |
| 3.994999  | 4     | XXXX  |
| 4.464999  | 4     | XXXX  |
| 4.934999  | 3     | XXX   |
| 5.404998  | 4     | XXXX  |
| 5.874998  | 3     | XXX   |
| 6.344998  | 5     | XXXXX |
| 6.814998  | 3     | XXX   |
| 7.284997  | 4     | XXXX  |
| 7.754997  | 3     | XXX   |
| 8.224998  | 4     | XXXX  |
| 8.694998  | 4     | XXXX  |
| 9.164998  | 4     | XXXX  |
| 9.634998  | 1     | X     |
| 0         | 75    |       |

| MIN       | MAX      | RANGE    | MEAN     | MEDIAN   | VARIANCE |
|-----------|----------|----------|----------|----------|----------|
| 0.1035329 | 9.514432 | 9.410899 | 4.824547 | 4.839019 | 7.577834 |

1 TITLE SDB: wipp::wipp\_copy Calc: PRELHS Ver: ING6.4 08/02/96 15:17:16  
 0 HISTOGRAM FOR VARIABLE NO. 4 LOGUNIFORM DISTRIBUTION

| MIDPOINT      | FREQ. |  |
|---------------|-------|--|
| 0.2149999E-13 | 55    | XX |
| 0.6449998E-13 | 4     | XXXX   |
| 0.1075000E-12 | 2     | XX   |
| 0.1505000E-12 | 2     | XX   |
| 0.1934999E-12 | 2     | XX   |
| 0.2364999E-12 | 1     | X  |
| 0.2794999E-12 | 1     | X  |
| 0.3224999E-12 | 1     | X  |
| 0.3654999E-12 | 1     | X  |
| 0.4084999E-12 | 1     | X  |
| 0.4514999E-12 | 0     |  |
| 0.4944999E-12 | 1     | X  |
| 0.5374999E-12 | 0     |  |
| 0.5804999E-12 | 1     | X  |
| 0.6234999E-12 | 0     |  |
| 0.6664999E-12 | 1     | X  |
| 0.7095000E-12 | 0     |  |
| 0.7525000E-12 | 0     |  |
| 0.7955000E-12 | 0     |  |
| 0.8385000E-12 | 1     | X  |
| 0.8815000E-12 | 1     | X  |
| 0             | 75    |  |

| MIN           | MAX           | RANGE         | MEAN          | MEDIAN        | VARIANCE    |
|---------------|---------------|---------------|---------------|---------------|-------------|
| 0.1076223E-16 | 0.8605560E-12 | 0.8605453E-12 | 0.8621589E-13 | 0.3403765E-14 | 0.3457749E- |

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1 TITLE SDB: wipp::wipp\_copy Calc: PRELHS Ver: ING6.4 08/02/96 15:17:16  
 0 HISTOGRAM FOR VARIABLE NO. 5 USER SUPPLIED DISTRIBUTION

| MIDPOINT | FREQ. |                    |
|----------|-------|--------------------|
| 4.094997 | 2     | XX                 |
| 5.004997 | 5     | XXXXX              |
| 5.914996 | 5     | XXXXX              |
| 6.824996 | 17    | XXXXXXXXXXXXXXXXXX |
| 7.734995 | 16    | XXXXXXXXXXXXXXXXXX |
| 8.644995 | 8     | XXXXXXXXXX         |
| 9.554995 | 4     | XXXX               |
| 10.46499 | 4     | XXXX               |
| 11.37499 | 4     | XXXX               |
| 12.28499 | 3     | XXX                |
| 13.19499 | 1     | X                  |
| 14.10499 | 2     | XX                 |
| 15.01499 | 1     | X                  |
| 15.92499 | 0     |                    |
| 16.83499 | 1     | X                  |
| 17.74499 | 0     |                    |
| 18.65499 | 1     | X                  |
| 19.56499 | 0     |                    |
| 20.47499 | 0     |                    |
| 21.38499 | 0     |                    |
| 22.29499 | 1     | X                  |
| 0        | 75    |                    |

| MIN      | MAX      | RANGE    | MEAN     | MEDIAN   | VARIANCE |
|----------|----------|----------|----------|----------|----------|
| 4.263539 | 22.53333 | 18.26979 | 8.638453 | 7.755095 | 10.28359 |



1 TITLE SDB: wipp::wipp\_copy Calc: PRELHS Ver: ING6.4 08/02/96 15:17:16  
 0 HISTOGRAM FOR VARIABLE NO. 6 USER SUPPLIED DISTRIBUTION

| MIDPOINT      | FREQ. |              |
|---------------|-------|--------------|
| 0.6174996E-01 | 1     | X            |
| 0.7124996E-01 | 0     |              |
| 0.8074996E-01 | 1     | X            |
| 0.9024996E-01 | 2     | XX           |
| 0.9974995E-01 | 4     | XXXX         |
| 0.1092499     | 7     | XXXXXXX      |
| 0.1187499     | 11    | XXXXXXXXXXXX |
| 0.1282499     | 6     | XXXXXX       |
| 0.1377499     | 4     | XXXX         |
| 0.1472499     | 6     | XXXXXX       |
| 0.1567499     | 3     | XXX          |
| 0.1662499     | 10    | XXXXXXXXXX   |
| 0.1757499     | 9     | XXXXXXXXXX   |
| 0.1852499     | 1     | X            |
| 0.1947499     | 2     | XX           |
| 0.2042499     | 5     | XXXXX        |
| 0.2137499     | 1     | X            |
| 0.2232499     | 0     |              |
| 0.2327499     | 1     | X            |
| 0.2422499     | 0     |              |
| 0.2517499     | 1     | X            |
| 0             | 75    |              |

| MIN           | MAX       | RANGE     | MEAN      | MEDIAN    | VARIANCE    |
|---------------|-----------|-----------|-----------|-----------|-------------|
| 0.5870640E-01 | 0.2482859 | 0.1895795 | 0.1467121 | 0.1439527 | 0.1413787E- |

1 TITLE SDB: wipp:wipp\_copy Calc: PRELHS Ver: ING6.4 08/02/96 15:17:16  
 0 HISTOGRAM FOR VARIABLE NO. 7 USER SUPPLIED DISTRIBUTION

| MIDPOINT     | FREQ. |              |
|--------------|-------|--------------|
| 0.420000E-01 | 5     | XXXXX        |
| 0.700001E-01 | 0     |              |
| 0.980001E-01 | 6     | XXXXXX       |
| 0.1260000    | 0     |              |
| 0.1540000    | 5     | XXXXX        |
| 0.1820000    | 6     | XXXXXX       |
| 0.2100000    | 4     | XXXX         |
| 0.2380000    | 12    | XXXXXXXXXXXX |
| 0.2660000    | 5     | XXXXX        |
| 0.2940000    | 5     | XXXXX        |
| 0.3220000    | 0     |              |
| 0.3500000    | 6     | XXXXXX       |
| 0.3780000    | 4     | XXXX         |
| 0.4060000    | 0     |              |
| 0.4340000    | 7     | XXXXXXX      |
| 0.4620000    | 0     |              |
| 0.4900000    | 0     |              |
| 0.5180000    | 0     |              |
| 0.5460000    | 4     | XXXX         |
| 0.5740000    | 0     |              |
| 0.6020000    | 6     | XXXXXX       |
| 0            | 75    |              |

| MIN          | MAX       | RANGE     | MEAN      | MEDIAN    | VARIANCE    |
|--------------|-----------|-----------|-----------|-----------|-------------|
| 0.508000E-01 | 0.6096000 | 0.5588000 | 0.2944717 | 0.2508300 | 0.2432861E- |

1 TITLE SDB: wipp::wipp\_copy Calc: PRELHS Ver: ING6.4 08/02/96 15:17:16  
 0 HISTOGRAM FOR VARIABLE NO. 8 TRIANGULAR DISTRIBUTION

| MIDPOINT      | FREQ. |        |
|---------------|-------|--------|
| 0.1400000E-07 | 6     | XXXXXX |
| 0.4200001E-07 | 6     | XXXXXX |
| 0.7000001E-07 | 6     | XXXXXX |
| 0.9800002E-07 | 5     | XXXXX  |
| 0.1260000E-06 | 6     | XXXXXX |
| 0.1540000E-06 | 5     | XXXXX  |
| 0.1820000E-06 | 4     | XXXX   |
| 0.2100000E-06 | 5     | XXXXX  |
| 0.2380000E-06 | 4     | XXXX   |
| 0.2660000E-06 | 4     | XXXX   |
| 0.2940000E-06 | 4     | XXXX   |
| 0.3220001E-06 | 3     | XXX    |
| 0.3500001E-06 | 2     | XX     |
| 0.3780001E-06 | 3     | XXX    |
| 0.4060001E-06 | 3     | XXX    |
| 0.4340001E-06 | 3     | XXX    |
| 0.4620001E-06 | 1     | X      |
| 0.4900002E-06 | 1     | X      |
| 0.5180001E-06 | 1     | X      |
| 0.5460001E-06 | 2     | XX     |
| 0.5740001E-06 | 1     | X      |
| 0             | 75    |        |

| MIN           | MAX           | RANGE         | MEAN          | MEDIAN        | VARIANCE    |
|---------------|---------------|---------------|---------------|---------------|-------------|
| 0.2629106E-08 | 0.5672543E-06 | 0.5646252E-06 | 0.2144814E-06 | 0.1862856E-06 | 0.2256038E- |

13

1 TITLE SDB: wipp::wipp\_copy Calc: PRELHS Ver: ING6.4 08/02/96 15:17:16  
 0 HISTOGRAM FOR VARIABLE NO. 9 STUDENT DISTRIBUTION

| MIDPOINT      | FREQ. |            |
|---------------|-------|------------|
| 0.9019998E-02 | 1     | X          |
| 0.9459998E-02 | 0     |            |
| 0.9899997E-02 | 1     | X          |
| 0.1034000E-01 | 1     | X          |
| 0.1078000E-01 | 1     | X          |
| 0.1122000E-01 | 3     | XXX        |
| 0.1166000E-01 | 3     | XXX        |
| 0.1210000E-01 | 5     | XXXXX      |
| 0.1253999E-01 | 6     | XXXXXX     |
| 0.1297999E-01 | 7     | XXXXXXXX   |
| 0.1341999E-01 | 9     | XXXXXXXXXX |
| 0.1385999E-01 | 8     | XXXXXXXXXX |
| 0.1429999E-01 | 7     | XXXXXXXXXX |
| 0.1473999E-01 | 7     | XXXXXXXXXX |
| 0.1517999E-01 | 4     | XXXX       |
| 0.1561999E-01 | 5     | XXXXX      |
| 0.1605999E-01 | 2     | XX         |
| 0.1649999E-01 | 2     | XX         |
| 0.1693999E-01 | 1     | X          |
| 0.1737999E-01 | 1     | X          |
| 0.1781999E-01 | 1     | X          |
| 0             | 75    |            |

| MIN           | MAX           | RANGE         | MEAN          | MEDIAN        | VARIANCE    |
|---------------|---------------|---------------|---------------|---------------|-------------|
| 0.9006235E-02 | 0.1779700E-01 | 0.8790762E-02 | 0.1367153E-01 | 0.1367379E-01 | 0.2835058E- |

1 TITLE SDB: wipp::wipp\_copy Calc: PRELHS Ver: ING6.4 08/02/96 15:17:16  
 0 HISTOGRAM FOR VARIABLE NO. 10 LOGSTUDENT DISTRIBUTION

| MIDPOINT      | FREQ. |                            |
|---------------|-------|----------------------------|
| 0.2199999E-04 | 9     | XXXXXXXXXX                 |
| 0.6599998E-04 | 21    | XXXXXXXXXXXXXXXXXXXXXXXXXX |
| 0.1100000E-03 | 17    | XXXXXXXXXXXXXXXXXXXXXX     |
| 0.1540000E-03 | 11    | XXXXXXXXXXXXXX             |
| 0.1979999E-03 | 6     | XXXXXX                     |
| 0.2419999E-03 | 4     | XXXX                       |
| 0.2859999E-03 | 2     | XX                         |
| 0.3299999E-03 | 1     | X                          |
| 0.3739999E-03 | 2     | XX                         |
| 0.4179999E-03 | 0     |                            |
| 0.4619999E-03 | 0     |                            |
| 0.5059998E-03 | 1     | X                          |
| 0.5499998E-03 | 0     |                            |
| 0.5939998E-03 | 0     |                            |
| 0.6379998E-03 | 0     |                            |
| 0.6819998E-03 | 0     |                            |
| 0.7259998E-03 | 0     |                            |
| 0.7699998E-03 | 0     |                            |
| 0.8139997E-03 | 0     |                            |
| 0.8579997E-03 | 0     |                            |
| 0.9019997E-03 | 1     | X                          |
| 0             | 75    |                            |

| MIN           | MAX           | RANGE         | MEAN          | MEDIAN        | VARIANCE    |
|---------------|---------------|---------------|---------------|---------------|-------------|
| 0.1028524E-04 | 0.8890320E-03 | 0.8787468E-03 | 0.1395047E-03 | 0.1067194E-03 | 0.1615176E- |

07

1TITLE SDB: wipp::wipp\_copy Calc: PRELHS Ver: ING6.4 08/02/96 15:17:16  
0CORRELATIONS AMONG INPUT VARIABLES CREATED BY THE LATIN HYPERCUBE SAMPLE FOR RAW DATA  
PAGE 1

|   |    |         |         |         |         |        |         |        |        |        |        |  |  |  |  |  |  |  |  |  |
|---|----|---------|---------|---------|---------|--------|---------|--------|--------|--------|--------|--|--|--|--|--|--|--|--|--|
| 0 | 1  | 1.0000  |         |         |         |        |         |        |        |        |        |  |  |  |  |  |  |  |  |  |
| 0 | 2  | -0.0686 | 1.0000  |         |         |        |         |        |        |        |        |  |  |  |  |  |  |  |  |  |
| 0 | 3  | 0.9827  | -0.0725 | 1.0000  |         |        |         |        |        |        |        |  |  |  |  |  |  |  |  |  |
| 0 | 4  | 0.0112  | -0.1254 | 0.0260  | 1.0000  |        |         |        |        |        |        |  |  |  |  |  |  |  |  |  |
| 0 | 5  | -0.0728 | 0.7182  | -0.0720 | -0.1281 | 1.0000 |         |        |        |        |        |  |  |  |  |  |  |  |  |  |
| 0 | 6  | 0.0011  | -0.0498 | -0.0279 | 0.5423  | 0.0065 | 1.0000  |        |        |        |        |  |  |  |  |  |  |  |  |  |
| 0 | 7  | -0.0122 | 0.2493  | -0.0188 | -0.0543 | 0.0979 | -0.0055 | 1.0000 |        |        |        |  |  |  |  |  |  |  |  |  |
| 0 | 8  | -0.0261 | 0.0863  | -0.0390 | 0.0366  | 0.0444 | -0.0307 | 0.0146 | 1.0000 |        |        |  |  |  |  |  |  |  |  |  |
| 0 | 9  | 0.0090  | 0.0449  | 0.0151  | 0.0195  | 0.0449 | 0.0354  | 0.0144 | 0.0035 | 1.0000 |        |  |  |  |  |  |  |  |  |  |
| 0 | 10 | -0.0744 | 0.0827  | -0.0771 | -0.0462 | 0.0858 | -0.0601 | 0.1137 | 0.0808 | 0.0187 | 1.0000 |  |  |  |  |  |  |  |  |  |
| 0 |    | 1       | 2       | 3       | 4       | 5      | 6       | 7      | 8      | 9      | 10     |  |  |  |  |  |  |  |  |  |

OVARIABLES

1TITLE SDB: wipp::wipp\_copy Calc: PRELHS Ver: ING6.4 08/02/96 15:17:16  
0CORRELATIONS AMONG INPUT VARIABLES CREATED BY THE LATIN HYPERCUBE SAMPLE FOR RANK DATA  
PAGE 1

|   |    |         |         |         |         |         |         |         |         |         |        |  |  |  |  |  |  |  |  |  |
|---|----|---------|---------|---------|---------|---------|---------|---------|---------|---------|--------|--|--|--|--|--|--|--|--|--|
| 0 | 1  | 1.0000  |         |         |         |         |         |         |         |         |        |  |  |  |  |  |  |  |  |  |
| 0 | 2  | 0.0033  | 1.0000  |         |         |         |         |         |         |         |        |  |  |  |  |  |  |  |  |  |
| 0 | 3  | 0.9989  | 0.0027  | 1.0000  |         |         |         |         |         |         |        |  |  |  |  |  |  |  |  |  |
| 0 | 4  | -0.0090 | 0.0281  | -0.0087 | 1.0000  |         |         |         |         |         |        |  |  |  |  |  |  |  |  |  |
| 0 | 5  | 0.0215  | 0.9540  | 0.0210  | 0.0416  | 1.0000  |         |         |         |         |        |  |  |  |  |  |  |  |  |  |
| 0 | 6  | -0.0109 | 0.0051  | -0.0083 | 0.7826  | -0.0041 | 1.0000  |         |         |         |        |  |  |  |  |  |  |  |  |  |
| 0 | 7  | -0.0360 | -0.0173 | -0.0392 | 0.0023  | 0.0048  | 0.0287  | 1.0000  |         |         |        |  |  |  |  |  |  |  |  |  |
| 0 | 8  | -0.0408 | -0.0357 | -0.0382 | -0.0213 | -0.0200 | -0.0161 | -0.0129 | 1.0000  |         |        |  |  |  |  |  |  |  |  |  |
| 0 | 9  | -0.0125 | -0.0399 | -0.0117 | 0.0127  | -0.0463 | 0.0313  | 0.0051  | 0.0030  | 1.0000  |        |  |  |  |  |  |  |  |  |  |
| 0 | 10 | 0.0393  | 0.0104  | 0.0389  | 0.0614  | 0.0061  | 0.1036  | 0.0294  | -0.0200 | -0.0031 | 1.0000 |  |  |  |  |  |  |  |  |  |
| 0 |    | 1       | 2       | 3       | 4       | 5       | 6       | 7       | 8       | 9       | 10     |  |  |  |  |  |  |  |  |  |

OVARIABLES

END OF APPENDIX B

## APPENDIX C: EXAMPLE OF AN LHS DEBUG FILE (LHS2\_T1.DBG)

Listed below is a Sample LHS ASCII output debug file, as described in Sec. 9.2. This file contains 75 outcome vectors, each with a parameter value for the 10 distributions sampled in the LHS run.

```

      1          10 7.3280208E-02 63.62719      0.5965481
1.9234693E-15 17.25994      0.1222811      0.4445000      2.6291065E-09
1.2351096E-02 1.8736359E-04
      2          10 0.1513023      0.7549241      7.622032
2.1510625E-17 7.653979      9.7291164E-02 0.1016000      8.0574807E-08
1.3748049E-02 8.7144545E-05
      3          10 0.1547620      1.291858      8.060068
1.4121704E-15 8.131407      0.1202511      0.2190800      5.6725429E-07
1.2599414E-02 1.7419629E-04
      4          10 9.8472208E-02 1.364809      1.949686
1.8812747E-13 9.074726      0.2047509      0.1936800      3.6406450E-07
1.3414560E-02 2.7439915E-04
      5          10 0.1272122      3.939600      4.972763
4.3676931E-16 10.33499      9.1931529E-02 0.3810000      1.8091364E-07
1.4108853E-02 7.1080416E-05
      6          10 0.1393572      0.3218293      6.417160
1.2884437E-17 6.066162      7.7384807E-02 0.3492500      1.8628558E-07
1.3280113E-02 1.8411643E-04
      7          10 0.1139428      0.8696704      3.594928
9.0359061E-16 7.448952      0.1640890      0.5588000      2.3438116E-07
1.3624636E-02 7.7143821E-05
      8          10 0.1433487      1.975383      6.764272
8.6055604E-13 8.172999      0.2311309      0.2190800      1.7183234E-07
1.1969556E-02 4.1344047E-05
      9          10 0.1002728      0.2068393      2.163121
5.2274210E-16 6.904873      0.1184673      0.4445000      4.9153317E-07
1.3673788E-02 6.8749374E-05
      10         10 9.1272287E-02 0.1777283      1.541897
5.7680152E-13 5.687442      0.1653022      0.1016000      3.3924158E-07
1.1576778E-02 6.4900800E-05
      11         10 0.1788063      2.062759      9.130220
2.3811680E-14 8.360855      0.1633120      0.2508300      1.2229651E-07
1.4454444E-02 2.4764022E-04
      12         10 0.1450122      5.164643      7.247185
2.6499159E-13 11.09884      0.1534645      0.1016000      8.4405656E-09
1.3093968E-02 5.2400021E-04
      13         10 0.1380753      0.5735260      6.365110
4.2065325E-15 8.344289      0.1310873      0.2794000      3.0192336E-07
1.2428843E-02 4.9119513E-05
      14         10 0.1420696      1.041418      6.882150
7.6025205E-15 7.933139      0.1231620      0.3048000      4.1357589E-07
1.2147442E-02 9.4606061E-05
      15         10 0.2000000      0.7332190      9.514432
4.2101275E-14 7.865863      0.1788032      0.5588000      1.2830606E-07
1.3044660E-02 1.2883257E-04
      16         10 0.1344257      3.026037      5.900851
1.1123850E-14 9.321473      0.1446289      0.1016000      7.6443996E-08
1.7239949E-02 9.9636345E-05
      17         10 0.1050506      0.3152083      2.939006
2.9671117E-16 6.434052      0.1709154      0.1016000      4.2217133E-07
1.3952975E-02 3.1982482E-04
      18         10 0.1478584      0.2131960      7.353649
8.3503424E-13 6.322580      0.1792119      0.3492500      2.8246518E-07
1.5949475E-02 1.9219682E-04
      19         10 0.1647849      1.220067      8.615486
3.3859702E-14 7.490495      0.1370754      0.1524000      4.8151549E-08
1.4054120E-02 1.3162589E-04
```

|               |               |               |               |               |
|---------------|---------------|---------------|---------------|---------------|
| 20            | 10            | 0.1126464     | 7.693554      | 3.307041      |
| 5.2453587E-15 | 12.38025      | 0.1619413     | 5.0799999E-02 | 3.0323781E-07 |
| 1.2068865E-02 | 9.0445908E-05 |               |               |               |
| 21            | 10            | 9.7526789E-02 | 0.6905217     | 1.961471      |
| 1.1094089E-13 | 7.853586      | 0.2028429     | 0.3810000     | 7.0950023E-08 |
| 1.6421216E-02 | 1.6613670E-04 |               |               |               |
| 22            | 10            | 0.1256319     | 0.9872297     | 4.839019      |
| 2.6003592E-15 | 8.298799      | 0.1396629     | 0.2508300     | 3.9597117E-07 |
| 1.1381858E-02 | 1.9851123E-04 |               |               |               |
| 23            | 10            | 0.1401118     | 4.7778096E-02 | 6.545784      |
| 1.4649925E-16 | 6.495473      | 0.1213904     | 0.4445000     | 3.1782619E-07 |
| 1.6929649E-02 | 2.3722368E-04 |               |               |               |
| 24            | 10            | 0.1750996     | 26.91002      | 9.026862      |
| 7.0465057E-16 | 14.03529      | 0.1616529     | 0.2508300     | 3.5513779E-08 |
| 1.1084677E-02 | 6.0778246E-05 |               |               |               |
| 25            | 10            | 9.5157012E-02 | 0.1576021     | 1.738652      |
| 1.7612964E-16 | 6.619277      | 0.1049080     | 0.1936800     | 4.5995870E-07 |
| 1.1633033E-02 | 1.0307696E-04 |               |               |               |
| 26            | 10            | 0.1011820     | 0.2678545     | 2.374225      |
| 8.8539656E-14 | 6.690193      | 0.1787046     | 0.2794000     | 2.8640841E-08 |
| 1.5610156E-02 | 1.7199584E-04 |               |               |               |
| 27            | 10            | 0.1846934     | 0.4285355     | 9.234701      |
| 1.3078763E-16 | 6.883809      | 0.1622201     | 0.2286000     | 1.5395500E-07 |
| 1.2939489E-02 | 1.6299590E-04 |               |               |               |
| 28            | 10            | 0.1228471     | 100.0001      | 4.418132      |
| 2.5135838E-16 | 18.62215      | 0.1439527     | 0.6096000     | 5.5252661E-07 |
| 1.5192318E-02 | 1.2548563E-04 |               |               |               |
| 29            | 10            | 0.1168638     | 8.4877029E-02 | 3.951081      |
| 6.4709696E-15 | 5.280710      | 0.1325730     | 0.1016000     | 1.0586962E-07 |
| 1.4361119E-02 | 9.5595082E-05 |               |               |               |
| 30            | 10            | 0.1165486     | 3.572831      | 3.423500      |
| 7.7583021E-14 | 7.537965      | 0.2063324     | 0.4445000     | 5.6224849E-08 |
| 1.3520175E-02 | 2.1800031E-04 |               |               |               |
| 31            | 10            | 0.1280610     | 2.871041      | 5.194157      |
| 4.1166858E-13 | 9.640755      | 0.1916573     | 0.6096000     | 1.2981957E-07 |
| 1.2480060E-02 | 1.4899854E-04 |               |               |               |
| 32            | 10            | 0.1099633     | 0.3780648     | 3.028706      |
| 1.5609601E-14 | 7.686137      | 0.1616584     | 0.2286000     | 3.4690783E-07 |
| 1.5244467E-02 | 2.9593604E-04 |               |               |               |
| 33            | 10            | 0.1605444     | 1.7633129E-02 | 8.309432      |
| 2.2224758E-16 | 4.942587      | 0.1224670     | 0.6096000     | 1.3593086E-07 |
| 1.4287069E-02 | 6.2830208E-05 |               |               |               |
| 34            | 10            | 8.5289389E-02 | 18.58241      | 1.164329      |
| 1.3073077E-15 | 22.53333      | 0.1558513     | 0.3048000     | 3.3502957E-07 |
| 1.5648989E-02 | 5.1689276E-05 |               |               |               |
| 35            | 10            | 0.1122020     | 0.2812901     | 3.703261      |
| 6.3289620E-17 | 7.077895      | 0.1251658     | 0.3492500     | 6.2363824E-08 |
| 1.2877205E-02 | 3.7722473E-04 |               |               |               |
| 36            | 10            | 0.1708282     | 6.706886      | 8.869353      |
| 2.5674614E-17 | 11.79441      | 0.1037802     | 0.5588000     | 2.3866812E-07 |
| 1.3214274E-02 | 1.0285244E-05 |               |               |               |
| 37            | 10            | 6.7988425E-02 | 2.481652      | 0.3734520     |
| 1.0793520E-15 | 8.617097      | 0.1953429     | 0.3492500     | 1.1351756E-07 |
| 1.3794910E-02 | 1.0671940E-04 |               |               |               |
| 38            | 10            | 0.1338438     | 6.294404      | 6.013595      |
| 1.5930748E-17 | 12.06803      | 0.1091249     | 0.2286000     | 1.1410077E-07 |
| 1.5496394E-02 | 4.3570009E-05 |               |               |               |
| 39            | 10            | 0.1462499     | 4.445203      | 7.152253      |
| 3.8664864E-15 | 10.30315      | 0.1464209     | 0.3492500     | 2.4841427E-08 |
| 9.9487221E-03 | 1.4223793E-04 |               |               |               |
| 40            | 10            | 0.1659205     | 0.1339801     | 8.580676      |
| 2.1057842E-14 | 5.038733      | 0.1782897     | 0.4445000     | 2.7371919E-07 |
| 1.2806865E-02 | 8.5564461E-05 |               |               |               |
| 41            | 10            | 8.1863850E-02 | 13.09887      | 0.8699561     |
| 5.5769777E-16 | 11.46535      | 0.1409624     | 0.1936800     | 9.8887426E-08 |



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|               |                  |               |               |               |
|---------------|------------------|---------------|---------------|---------------|
| 1.3595122E-02 | 7.8473153E-05    |               |               |               |
| 42            | 10 0.1365243     | 1.511392      | 6.111771      |               |
| 2.7443010E-14 | 9.845539         | 0.1751550     | 0.1524000     | 2.5655095E-07 |
| 1.4779377E-02 | 1.3755888E-04    |               |               |               |
| 43            | 10 0.1030995     | 3.1308506E-02 | 2.330700      |               |
| 4.1561614E-17 | 4.263539         | 0.1288913     | 0.2794000     | 2.7075896E-07 |
| 1.4021403E-02 | 1.3431942E-04    |               |               |               |
| 44            | 10 0.1327458     | 2.213681      | 5.407843      |               |
| 1.3412305E-13 | 8.653215         | 0.1454658     | 0.1936800     | 6.6447683E-08 |
| 1.1299099E-02 | 9.1260445E-05    |               |               |               |
| 45            | 10 8.2906216E-02 | 0.5315294     | 1.012496      |               |
| 2.4158873E-15 | 7.148599         | 0.1136251     | 0.2286000     | 1.8593823E-08 |
| 1.4401330E-02 | 2.9413122E-05    |               |               |               |
| 46            | 10 9.0117767E-02 | 0.6120414     | 1.197986      |               |
| 1.8028972E-13 | 7.212472         | 0.1783139     | 5.0799999E-02 | 2.4756423E-07 |
| 1.4587302E-02 | 5.3642085E-05    |               |               |               |
| 47            | 10 0.1464944     | 0.2335171     | 6.928454      |               |
| 2.0330873E-16 | 6.844434         | 9.9600650E-02 | 0.5588000     | 2.0766581E-07 |
| 1.5402320E-02 | 1.1744622E-04    |               |               |               |
| 48            | 10 0.1564112     | 0.1477797     | 7.886711      |               |
| 3.7985304E-14 | 6.373179         | 0.1781164     | 0.3048000     | 2.6012063E-07 |
| 1.4667201E-02 | 6.6187415E-05    |               |               |               |
| 49            | 10 0.1579363     | 8.9082204E-02 | 8.080680      |               |
| 3.5787939E-13 | 5.725170         | 0.1866331     | 0.1936800     | 3.7967766E-08 |
| 1.5768245E-02 | 1.5546622E-04    |               |               |               |
| 50            | 10 0.1079620     | 1.1793508E-02 | 2.617618      |               |
| 3.2567828E-17 | 4.469033         | 0.1061364     | 0.1524000     | 4.4892431E-08 |
| 9.0062348E-03 | 1.5065874E-04    |               |               |               |
| 51            | 10 0.1148041     | 5.628944      | 3.837155      |               |
| 5.6989707E-17 | 9.443014         | 0.1083585     | 0.2508300     | 3.7088330E-07 |
| 1.3496452E-02 | 2.5576459E-05    |               |               |               |
| 52            | 10 0.1093676     | 0.4127070     | 3.228415      |               |
| 5.1356917E-13 | 6.669279         | 0.2482859     | 0.2508300     | 8.7244132E-08 |
| 1.4528912E-02 | 8.3627012E-05    |               |               |               |
| 53            | 10 0.1242053     | 14.49025      | 4.662136      |               |
| 1.0762231E-17 | 10.53202         | 5.8706399E-02 | 0.2190800     | 9.6569408E-08 |
| 1.4865128E-02 | 3.9140976E-04    |               |               |               |
| 54            | 10 0.1367780     | 0.8148080     | 6.240638      |               |
| 1.0285855E-16 | 7.054192         | 0.1218744     | 0.1524000     | 9.2669154E-08 |
| 1.7796997E-02 | 8.0840939E-05    |               |               |               |
| 55            | 10 0.1181085     | 2.5895631E-02 | 4.318312      |               |
| 7.7071574E-17 | 4.680175         | 0.1772722     | 0.3492500     | 1.4951024E-07 |
| 1.0833760E-02 | 1.1053683E-04    |               |               |               |
| 56            | 10 7.1257107E-02 | 21.60214      | 0.5453258     |               |
| 1.6519887E-14 | 12.50172         | 0.1126175     | 0.6096000     | 4.4580383E-07 |
| 1.3852228E-02 | 8.8903203E-04    |               |               |               |
| 57            | 10 4.9999982E-02 | 0.4771105     | 0.1035329     |               |
| 3.8962493E-17 | 6.982884         | 0.1176726     | 0.2286000     | 2.2788998E-07 |
| 1.1899312E-02 | 5.6912944E-05    |               |               |               |
| 58            | 10 0.1063877     | 10.10114      | 2.805689      |               |
| 3.8143699E-16 | 10.04485         | 0.1238157     | 0.6096000     | 1.5705666E-07 |
| 1.5025233E-02 | 1.2019412E-04    |               |               |               |
| 59            | 10 0.1319585     | 1.640603      | 5.573914      |               |
| 5.8459389E-15 | 8.932034         | 0.1230750     | 0.4445000     | 2.2803476E-08 |
| 1.1789343E-02 | 4.7118636E-05    |               |               |               |
| 60            | 10 7.7220090E-02 | 2.579523      | 0.7965167     |               |
| 7.7874727E-16 | 8.245615         | 0.1209193     | 0.4445000     | 1.7510411E-07 |
| 1.3884971E-02 | 1.1344437E-04    |               |               |               |
| 61            | 10 0.1219810     | 1.800795      | 4.516323      |               |
| 1.7079580E-15 | 7.755095         | 0.1460320     | 0.1936800     | 4.4088267E-07 |
| 1.0551646E-02 | 1.0850145E-04    |               |               |               |
| 62            | 10 0.1250420     | 0.5108180     | 5.053633      |               |
| 6.5358618E-13 | 7.273052         | 0.1794562     | 0.3810000     | 3.9259916E-07 |
| 1.4266257E-02 | 3.7045967E-05    |               |               |               |
| 63            | 10 5.6780986E-02 | 6.9671281E-02 | 0.2050413     |               |

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| 6.2133173E-14 | 6.520731      | 0.1433461     | 0.3810000     | 1.1932570E-08 |
| 1.4729307E-02 | 5.4807544E-05 |               |               |               |
| 64            | 10            | 8.7681592E-02 | 0.9450914     | 1.368773      |
| 1.5041724E-13 | 7.590703      | 0.2074768     | 0.2190800     | 3.7642897E-07 |
| 1.6072515E-02 | 5.8800248E-05 |               |               |               |
| 65            | 10            | 0.1694444     | 43.32738      | 8.733203      |
| 1.2136436E-14 | 13.83318      | 0.1697805     | 0.2794000     | 1.4116557E-07 |
| 1.4918862E-02 | 4.0280109E-05 |               |               |               |
| 66            | 10            | 0.1040974     | 3.278795      | 2.537466      |
| 2.2426594E-17 | 8.047125      | 0.1009143     | 5.0799999E-02 | 2.1568516E-07 |
| 1.4197263E-02 | 7.5344571E-05 |               |               |               |
| 67            | 10            | 0.1882886     | 1.764420      | 9.385925      |
| 8.6262021E-17 | 8.020835      | 0.1153496     | 0.1524000     | 5.0891452E-07 |
| 1.5070859E-02 | 2.2566486E-04 |               |               |               |
| 68            | 10            | 0.1206580     | 0.1082716     | 4.133991      |
| 1.4413632E-17 | 6.770254      | 8.5789055E-02 | 0.2794000     | 5.1004463E-08 |
| 1.2680155E-02 | 9.8165649E-05 |               |               |               |
| 69            | 10            | 0.1291035     | 5.5597901E-02 | 5.343535      |
| 3.4037646E-15 | 5.352950      | 0.1260840     | 0.3048000     | 1.6228006E-07 |
| 1.3115174E-02 | 2.2318589E-05 |               |               |               |
| 70            | 10            | 0.1190686     | 0.1241056     | 4.094585      |
| 5.3811607E-14 | 6.089011      | 0.1617419     | 0.6096000     | 2.9141935E-07 |
| 1.2656707E-02 | 2.5947127E-04 |               |               |               |
| 71            | 10            | 0.1306657     | 1.124214      | 5.753356      |
| 3.3229620E-13 | 7.372777      | 0.1595809     | 0.2286000     | 5.3539804E-07 |
| 1.2775521E-02 | 7.2786097E-05 |               |               |               |
| 72            | 10            | 0.1528356     | 0.3562421     | 7.790301      |
| 5.1642921E-17 | 7.306887      | 0.1050647     | 5.0799999E-02 | 3.2159124E-07 |
| 1.6351957E-02 | 3.4336434E-05 |               |               |               |
| 73            | 10            | 9.3713492E-02 | 11.06588      | 1.669584      |
| 2.4111122E-13 | 14.56196      | 0.2034764     | 0.3048000     | 2.0370047E-07 |
| 1.3335303E-02 | 1.1474429E-04 |               |               |               |
| 74            | 10            | 0.1493086     | 8.811837      | 7.455116      |
| 9.7797306E-15 | 13.06471      | 0.1355448     | 5.0799999E-02 | 1.9755512E-07 |
| 1.2246166E-02 | 2.0962505E-04 |               |               |               |
| 75            | 10            | 0.1617232     | 4.291430      | 8.404033      |
| 6.5828033E-14 | 10.93172      | 0.2177944     | 0.2508300     | 2.2250225E-07 |
| 1.3243208E-02 | 1.4461970E-04 |               |               |               |

END OF APPENDIX C  
END OF THE USER'S MANUAL

Information Only