SOFTWARE RELEASE NOTICE

01. SRN Number: PA-SRN-011	
02. Project Title: LHS - Latin Hypercube and Random Samples for Use With Computer Models.	Project No.
03. SRN Title: LHS Version 1.1	
04. Originator/Requester: Thomas J. Ratchford	Date: 01/10/94

05. Summary of Actions

- ■ Release of new code admitted to CM System
- ☐ Release of modified code:
  - ☐ Enhancements made
  - ☐ Corrections made
- ☐ Change of access code

06. Persons Authorized Access

Name	RO/RW	A/C/D

07. Element Manager Approval: Date:

08. Remarks:

CNWRA Form TOP-6 (08/93)

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08. Remarks:

CNWRA Form TOP-6 (08/93)

SOFTWARE SUMMARY FORM

01.Summary Date: 01/10/94	02. Summary prepared by(Name and Phone) T.J. Ratchford 522-3083	03. Summary Action: New
04. Software Date: 8/15/93	05. Short Title: LHS	
06. Software Title: LHS - Latin Hypercube and Random Samples for Use With Computer Models.		07. Internal Software ID: NONE

08. Software Type: ☐ Automated Data System ■ Computer Program ☐ Subroutine/Module	09.Processing Mode: ☐ Interactive ☐ Batch ■ Combination	10. APPLICATION AREA A. General: ☐ Scientific/Engineering ☐ Auxiliary Analyses ☐ Total System PA ■ Subsystem PA ☐ Other b. Specific:

11. Submitting Organization and Address: CNWRA, SwRI, San Antonio, Texas	12. Technical Contact(s) and Phone: R. Janetzke, (210) 522-3318

13. Narrative:
LHS has been designed for the generation of either Latin Hypercube or random multivariate samples. The Latin Hypercube employs a constrained sample scheme, whereas random sampling corresponds to a simple Monte Carlo technique.

14. Computer Platform CRAY/XMP	15. Computer Operating System: UNIX	16. Programming Language(s): FORTRAN	17. Number of Source Program Statements: 25,980 lines of code
18. Computer Memory Requirements: UNKNOWN	19. Tape Drives: NONE	20. Disk/Drum Units: N/A	21. Graphics: UNKNOWN

22. Other Operational Requirements

NONE

23. Software Availability: ■ Available ☐ Limited ☐ In-House ONLY	24. Documentation Availability: ■ Available ☐ Inadequate ☐ In-House ONLY

25. Submission Package Status:

Acceptance Criteria: Met ■ Not Met ☐ Software QA Assessment: Successful ■ Unsuccessful ☐

Code Custodian: T.J. Ratchford Date: 1/7/94

CNWRA Form TOP-4-1 (08/93)

Cray Directory Listing

```
-r--r-----   1 tjr1      tjr1        3022 Jul  8  1993 s.Makefile
-r--r-----   1 tjr1      tjr1         466 Jul  8  1993 s.TPA_LHS.LGD
-rwxrwxr-x   1 tjr1      tjr1        1803 Jul  8  1993 s.banner.F*
-rwxrwxr-x   1 tjr1      tjr1        1125 Jul  8  1993 s.beta.F*
-rwxrwxr-x   1 tjr1      tjr1         452 Jul  8  1993 s.betafn.F*
-rwxrwxr-x   1 tjr1      tjr1       13875 Jul  8  1993 s.betaic.F*
-rwxrwxr-x   1 tjr1      tjr1        4912 Jul  8  1993 s.betaln.F*
-rwxrwxr-x   1 tjr1      tjr1        1534 Jul  8  1993 s.chkdat.F*
-rwxrwxr-x   1 tjr1      tjr1        1987 Jul  8  1993 s.chkdim.F*
-rwxrwxr-x   1 tjr1      tjr1        2373 Jul  8  1993 s.chkstr.F*
-rwxrwxr-x   1 tjr1      tjr1         709 Jul  8  1993 s.chktri.F*
-rwxrwxr-x   1 tjr1      tjr1         813 Jul  8  1993 s.chkzro.F*
-rwxrwxr-x   1 tjr1      tjr1        1301 Jul  8  1993 s.chlsky.F*
-rwxrwxr-x   1 tjr1      tjr1        2431 Jul  8  1993 s.cmcrd.F*
-r--r-----   1 tjr1      tjr1         826 Jul  8  1993 s.comm1.H
-r--r-----   1 tjr1      tjr1         421 Jul  8  1993 s.const.H
-rwxrwxr-x   1 tjr1      tjr1         863 Jul  8  1993 s.consta.F*
-rwxrwxr-x   1 tjr1      tjr1        1666 Jul  8  1993 s.corcal.F*
-rwxrwxr-x   1 tjr1      tjr1        1133 Jul  8  1993 s.corout.F*
-rwxrwxr-x   1 tjr1      tjr1         896 Jul  8  1993 s.datout.F*
-rwxrwxr-x   1 tjr1      tjr1        1933 Jul  8  1993 s.datsqz.F*
-rwxrwxr-x   1 tjr1      tjr1        1122 Jul  8  1993 s.dmfsd.F*
-rwxrwxr-x   1 tjr1      tjr1        1162 Jul  8  1993 s.dsinv.F*
-rwxrwxr-x   1 tjr1      tjr1        3251 Jul  8  1993 s.errchk.F*
-rwxrwxr-x   1 tjr1      tjr1         881 Jul  8  1993 s.errget.F*
-rwxrwxr-x   1 tjr1      tjr1         811 Jul  8  1993 s.errprt.F*
-rwxrwxr-x   1 tjr1      tjr1         791 Jul  8  1993 s.erstgt.F*
-rwxrwxr-x   1 tjr1      tjr1        1897 Jul  8  1993 s.erxset.F*
-rwxrwxr-x   1 tjr1      tjr1        1376 Jul  8  1993 s.fdump.F*
-rwxrwxr-x   1 tjr1      tjr1        1425 Jul  8  1993 s.findit.F*
-rwxrwxr-x   1 tjr1      tjr1        4774 Jul  8  1993 s.finver.F*
-rwxrwxr-x   1 tjr1      tjr1         460 Jul  8  1993 s.finvnor.F*
-rwxrwxr-x   1 tjr1      tjr1        2724 Jul  8  1993 s.histo.F*
-rwxrwxr-x   1 tjr1      tjr1        1103 Jul  8  1993 s.hpsrt.F*
-rwxrwxr-x   1 tjr1      tjr1        1400 Jul  8  1993 s.hstout.F*
-rwxrwxr-x   1 tjr1      tjr1         888 Jul  8  1993 s.hypgeo.F*
-rwxrwxr-x   1 tjr1      tjr1       13551 Jul  8  1993 s.i1mach.F*
-rwxrwxr-x   1 tjr1      tjr1        5468 Jul  8  1993 s.imtql2.F*
-rwxrwxr-x   1 tjr1      tjr1        2781 Jul  8  1993 s.j4save.F*
-rwxrwxr-x   1 tjr1      tjr1       11658 Jul  8  1993 s.lhs.F*
-rwxrwxr-x   1 tjr1      tjr1      183129 Jul  8  1993 s.lhs.cpp*
-rwxrwxr-x   1 tjr1      tjr1      398550 Jul  8  1993 s.lhs.f*
-rwxrwxr-x   1 tjr1      tjr1      184823 Jul  8  1993 s.lhs.pre*
-rw-r-----   1 tjr1      tjr1       27461 Jul  8  1993 s.lhsrep.inp
-r--r-----   1 tjr1      tjr1        7534 Jul  8  1993 s.lhsrep.inp.Z
-rwxrwxr-x   1 tjr1      tjr1         912 Jul  8  1993 s.matinv.F*
-rwxrwxr-x   1 tjr1      tjr1        4457 Jul  8  1993 s.mix.F*
-rwxrwxr-x   1 tjr1      tjr1        1264 Jul  8  1993 s.normal.F*
-rwxrwxr-x   1 tjr1      tjr1        1499 Jul  8  1993 s.onechk.F*
-rwxrwxr-x   1 tjr1      tjr1        1398 Jul  8  1993 s.outcrd.F*
-rwxrwxr-x   1 tjr1      tjr1        4058 Jul  8  1993 s.outdat.F*
-r--r-----   1 tjr1      tjr1         826 Jul  8  1993 s.param1.H
-rwxrwxr-x   1 tjr1      tjr1        2677 Jul  8  1993 s.pmtrx.F*
-rwxrwxr-x   1 tjr1      tjr1        1559 Jul  8  1993 s.posdef.F*
-rwxrwxr-x   1 tjr1      tjr1         834 Jul  8  1993 s.pythag.F*
-rwxrwxr-x   1 tjr1      tjr1        7215 Jul  8  1993 s.r1mach.F*
-rwxrwxr-x   1 tjr1      tjr1        1017 Jul  8  1993 s.ran.F*
-rwxrwxr-x   1 tjr1      tjr1        1465 Jul  8  1993 s.ranker.F*
-rwxrwxr-x   1 tjr1      tjr1        7546 Jul  8  1993 s.rdpar.F*
-rwxrwxr-x   1 tjr1      tjr1        4103 Jul  8  1993 s.rierfc1.F*
-rwxrwxr-x   1 tjr1      tjr1        1499 Jul  8  1993 s.s88fmt.F*
-rwxrwxr-x   1 tjr1      tjr1         863 Jul  8  1993 s.setdef.F*
-rwxrwxr-x   1 tjr1      tjr1         540 Jul  8  1993 s.sift.F*
```

```
-rwxrwxr-x   1 tjr1      tjr1         4456 Jul  8  1993 s.sspev.F*
-rwxrwxr-x   1 tjr1      tjr1         4699 Jul  8  1993 s.tqlrat.F*
-rwxrwxr-x   1 tjr1      tjr1         3170 Jul  8  1993 s.trbak3.F*
-rwxrwxr-x   1 tjr1      tjr1         4181 Jul  8  1993 s.tred3.F*
-rwxrwxr-x   1 tjr1      tjr1          987 Jul  8  1993 s.triang.F*
-rwxrwxr-x   1 tjr1      tjr1         1403 Jul  8  1993 s.unifrm.F*
-rwxrwxr-x   1 tjr1      tjr1         4442 Jul  8  1993 s.usrdst.F*
-rwxrwxr-x   1 tjr1      tjr1          878 Jul  8  1993 s.vif.F*
-rwxrwxr-x   1 tjr1      tjr1          899 Jul  8  1993 s.wrtcrd.F*
-rwxrwxr-x   1 tjr1      tjr1         3006 Jul  8  1993 s.wrtpar.F*
-r--r-----   1 tjr1      tjr1          347 Jul  8  1993 s.x.lhs.covr
-r--r-----   1 tjr1      tjr1          461 Jul  8  1993 s.x.lhs.test
-rwxrwxr-x   1 tjr1      tjr1         1458 Jul  8  1993 s.xerabt.F*
-rwxrwxr-x   1 tjr1      tjr1         2307 Jul  8  1993 s.xerctl.F*
-rwxrwxr-x   1 tjr1      tjr1         2716 Jul  8  1993 s.xerprt.F*
-rwxrwxr-x   1 tjr1      tjr1         2459 Jul  8  1993 s.xerror.F*
-rwxrwxr-x   1 tjr1      tjr1         6000 Jul  8  1993 s.xerrwv.F*
-rwxrwxr-x   1 tjr1      tjr1         4491 Jul  8  1993 s.xersav.F*
-rwxrwxr-x   1 tjr1      tjr1         2039 Jul  8  1993 s.xgetua.F*

                         Total Number of Files = 296
```

LHS Fortran Program
Static and Dynamic Analysis

June 29, 1993

Earl S. Marwil
John E. Tolli
Scientific Computing Unit
Idaho National Engineering Laboratory

1. Introduction

This analysis was performed on the Cray version of the software as provided by Southwest Research Institute (SwRI).

One sample problem was supplied along with the source code. The program was analyzed using the Craft (Cross Reference Analysis of Fortran) tool, FORWARN, the Fortran 77 analyzer, and PC-Metric. These tools provide static analysis, coverage analysis, and complexity analysis.

2. References

[1] N.H. Marshall and E.S. Marwil, Cross Reference Analysis of Fortran (CRAFT), EG&G-CATT-9198, EG&G Idaho, Inc., July 1991.
[2] Fortran 77 Analyzer User's Manual, National Bureau of Standards, NBS GCR 81-359, 1981
[3] FORWARN User's Guide, Quibus Enterprises, Inc., July 1991.
[4] PC-Metric User's Guide, SET Laboratories, Inc., 1987.

3. Functions

The LHS program contains 70 Fortran routines.

LHS has 1 alternate entry point ("gamaln" in "betaln"), 1 uncalled statement function ("loc" in "consta"), and 3 uncalled subroutines ("betafn", "onechk", "wrtpar"). Due to the uncalled routines, some other modules are never used (e.g., "betaic", "betaln", "hypgeo") and can therefore be eliminated from the program.

4. Common Block Irregularities

There are 14 common blocks in the LHS program.

All common block declarations are consistent.

Common block "work" is declared only once (in "posdef"). It could therefore be eliminated and its contents made local to "posdef".

Since "betafn" is never called, variable "nz" in common block "pq" is never used and could therefore be eliminated.

There are many instances of a common block being declared in a routine in which none of its elements are otherwise referenced.

5. Interface Irregularities

Subroutine "mix" passes 1 argument to subroutine "matinv" which has no arguments.

6. Local Variable Irregularities

Parameter "lent" is assigned a value of 125 everywhere it is declared, except for "datsqz" in which it is assigned a value of 11.

There are several instances of a parameter not being used in a module in which it is declared.

There are several instances of a variable being undefined, unused, or both in a module in which it is declared.

7. Fortran Extensions

The routines "banner", "chkzro", "consta", "lhs", "rdpar", and "setdef" all contain some lower case alphabetic characters in their active Fortran.

Several routines have entity names which are longer than 6 characters.

Module "lhs" has 3 format statements containing the "x" descriptor without a repeat count.

Some variables are assigned boolean values in "i1mach" and "r1mach".

A real variable is filled with a character constant string in "setdef".

Normal program termination is achieved by use of a CALL EXIT statement in the main program module "lhs". This is somewhat archaic and could be eliminated (allowing the program to terminate normally via the main program END statement), or it could be replaced by the more usual Fortran STOP statement.

8. Optimization

The following table summarizes the performance data gathered from execution of the sample problem. Only those routines exercised by the sample problem are shown (see "Coverage Analysis" for a list of routines not exercised by the sample problem, i.e., coverage = 0%). The table lists all program modules in descending order according to CPU time. To optimize code execution time, emphasis should be placed on those modules which appear highest in the listing.

In order to obtain meaningful statistics for performance evaluation, the program should execute for a reasonable amount of time. Note that the execution time for this sample problem is short (< 10 sec) and that the resulting statistics may therefore not accurately reflect program performance for longer runs.

The performance data show that a high percentage of the overall execution time (91.472%) is spent in the first 3 routines listed (CORCAL, RAN, MIX). This is due primarily to the following (applies to some or all of the 3 routines):

1) a low percentage of floating point operations which are performed in vector mode (%Vflops is small)

2) a high overhead factor for calls to the routines (IFact > 1)

3) a high rate of instruction buffer fetches (IBFR > 1).

A detailed optimization analysis effort should focus on these 3 areas.

PERFORMANCE DATA FOR LHS

ROUTINE NAME	Time	%ExTime	%AccumT	%Vflops	IFact	MC/MR	IBFR
CORCAL	4.773	54.502	54.502	93.84834	0.00	0.108	0.000
RAN	1.839	20.994	75.495	0.00000	685.15	1.000	0.838
MIX	1.399	15.977	91.472	63.98357	0.00	0.448	1.334
LHS	0.424	4.836	96.308	0.00000	0.00	0.373	0.957
UNIFRM	0.087	0.992	97.300	0.00000	0.01	0.101	1.156
HPSRT	0.083	0.953	98.253	0.00000	0.01	0.948	0.008
RDPAR	0.058	0.667	98.919	0.00000	0.00	0.206	0.968
RANKER	0.026	0.295	99.215	100.00000	0.03	0.752	0.094
WRTCRD	0.015	0.171	99.386	0.00000	0.05	0.420	1.111
NORMAL	0.014	0.164	99.550	0.00000	0.00	0.160	1.142
CHKDAT	0.014	0.156	99.706	0.00000	0.06	0.364	1.284
RIERFC1	0.013	0.147	99.853	0.00000	1.91	0.219	0.423
FINVNOR	0.007	0.079	99.932	0.00000	3.54	0.229	0.738
CONSTA	0.005	0.058	99.990	0.00000	0.03	0.236	1.316
BANNER	0.001	0.009	99.999	0.00000	0.00	1.465	0.436
DATSQZ	0.000	0.000	100.000	0.00000	0.00	0.266	0.700
SETDEF	0.000	0.000	100.000	0.00000	0.00	0.008	0.157
CHKDIM	0.000	0.000	100.000	0.00000	0.01	0.333	1.088
CHKZRO	0.000	0.000	100.000	0.00000	0.00	0.750	1.108
Totals (All Traced Routines)	8.757	100.000	100.000	88.02775	147.67	0.170	0.462

Key:

%AccumT - accumulated percentage of total CPU time
%ExTime - percentage of total CPU time
%Vflops - percentage of floating point operations due to vector floating point operations
IBFR - Instruction Buffer Fetch Rate (megafetches/sec)
IFact - Inline Factor (total calls to routine / average time spent in routine for each call)
MC - number of memory conflicts
MR - number of memory references
Time - total CPU time (sec)

9. Coverage Analysis

One sample problem was supplied. The global data used as input for the test problem was obtained from TPA_LHS.LGD in directory /u4/zke/csdv. This file was modified to cause the test problem to run for 50 observations instead of 1 in order to produce a consequence data output file in agreement with that which resides in the /u4/zke directory (i.e., /u4/zke/oooo/lhs50v.out).

A coverage analysis shows that this problem yielded an 18% segment coverage of LHS. Sample problems provided with simulation programs typically achieve 35% to 50% coverage. A statement of software quality cannot be made for routines that have low coverage, i.e., large portions of the code are untested.

Note that 51 routines have 0% coverage. These routines are not tested with the supplied sample problem.

Seven routines achieve 40%-59% coverage, 4 routines achieve 60%-79% coverage, 5 routines achieve 80%-99% coverage, and 3 routines achieve 100% coverage.

The following table shows the percent coverage for each routine.

Module Name	Number of Segments in module	Number of Segments Executed	Percent Segment Coverage
LHS	78	45	57.7
BANNER	13	7	53.8
BETA	7	0	0.0
BETAFN	5	0	0.0
BETAIC	206	0	0.0
BETALN	66	0	0.0
CHKDAT	10	6	60.0
CHKDIM	15	8	53.3
CHKSTR	16	0	0.0
CHKTRI	4	0	0.0
CHKZRO	7	4	57.1
CHLSKY	15	0	0.0
CMCRD	36	0	0.0
CONSTA	1	1	100.0
CORCAL	28	27	96.4
COROUT	13	0	0.0
DATOUT	7	0	0.0
DATSQZ	22	17	77.3
DMFSD	20	0	0.0
DSINV	19	0	0.0
ERRCHK	17	0	0.0
ERRGET	1	0	0.0
ERRPRT	1	0	0.0
ERSTGT	9	0	0.0
ERXSET	1	0	0.0
FDUMP	1	0	0.0
FINDIT	28	0	0.0
FINVER	62	0	0.0

Module Name	Number of Segments in module	Number of Segments Executed	Percent Segment Coverage
FINVNO	8	6	75.0
HISTO	57	0	0.0
HPSRT	18	18	100.0
HSTOUT	6	0	0.0
HYPGEO	9	0	0.0
I1MACH	4	0	0.0
IMTQL2	40	0	0.0
J4SAVE	3	0	0.0
MATINV	11	0	0.0
MIX	63	35	55.6
NORMAL	15	14	93.3
ONECHK	7	0	0.0
OUTCRD	14	0	0.0
OUTDAT	72	0	0.0
PMTRX	50	0	0.0
POSDEF	6	0	0.0
PYTHAG	6	0	0.0
R1MACH	3	0	0.0
RAN	7	6	85.7
RANKER	27	16	59.3
RDPAR	54	34	63.0
RIERFC	15	13	86.7
S88FMT	4	0	0.0
SETDEF	5	5	100.0
SIFT	21	0	0.0
SSPEV	21	0	0.0
TQLRAT	49	0	0.0
TRBAK3	15	0	0.0
TRED3	27	0	0.0
TRIANG	10	0	0.0
UNIFRM	21	16	76.2
USRDST	30	0	0.0
VIF	5	0	0.0
WRTCRD	7	6	85.7
WRTPAR	17	0	0.0
XERABT	1	0	0.0
XERCTL	1	0	0.0
XERPRT	20	0	0.0
XERROR	1	0	0.0
XERRWV	56	0	0.0
XERSAV	35	0	0.0
XGETUA	6	0	0.0
Totals	1555	284	18.3

```
                    0.20      0.40      0.60      0.80      1.00
             ----+----|----+----|----+----|----+----|----+----|
LHS         |*****************************|         |         |
BANNER      |***************************  |         |         |
BETA        |         |         |         |         |         |
BETAFN      |         |         |         |         |         |
BETAIC      |         |         |         |         |         |
BETALN      |         |         |         |         |         |
CHKDAT      |******************************         |         |
CHKDIM      |***************************  |         |         |
CHKSTR      |         |         |         |         |         |
CHKTRI      |         |         |         |         |         |
CHKZRO      |*****************************|         |         |
CHLSKY      |         |         |         |         |         |
CMCRD       |         |         |         |         |         |
CONSTA      |**************************************************
CORCAL      |************************************************ |
COROUT      |         |         |         |         |         |
DATOUT      |         |         |         |         |         |
DATSQZ      |***************************************|         |
DMFSD       |         |         |         |         |         |
DSINV       |         |         |         |         |         |
ERRCHK      |         |         |         |         |         |
ERRGET      |         |         |         |         |         |
ERRPRT      |         |         |         |         |         |
ERSTGT      |         |         |         |         |         |
ERXSET      |         |         |         |         |         |
FDUMP       |         |         |         |         |         |
FINDIT      |         |         |         |         |         |
FINVER      |         |         |         |         |         |
FINVNO      |************************************** |         |
HISTO       |         |         |         |         |         |
HPSRT       |**************************************************
HSTOUT      |         |         |         |         |         |
HYPGEO      |         |         |         |         |         |
I1MACH      |         |         |         |         |         |
IMTQL2      |         |         |         |         |         |
J4SAVE      |         |         |         |         |         |
MATINV      |         |         |         |         |         |
MIX         |**************************** |         |         |
NORMAL      |***********************************************  |
ONECHK      |         |         |         |         |         |
OUTCRD      |         |         |         |         |         |
OUTDAT      |         |         |         |         |         |
PMTRX       |         |         |         |         |         |
POSDEF      |         |         |         |         |         |
PYTHAG      |         |         |         |         |         |
R1MACH      |         |         |         |         |         |
RAN         |*******************************************      |
RANKER      |******************************         |         |
RDPAR       |*******************************        |         |
RIERFC      |*******************************************      |
S88FMT      |         |         |         |         |         |
             ----+----|----+----|----+----|----+----|----+----|
```

```
                   0.20      0.40      0.60      0.80      1.00
             ----+----|----+----|----+----|----+----|----+----|
SETDEF      |**************************************************
SIFT        |         |         |         |         |         |
SSPEV       |         |         |         |         |         |
TQLRAT      |         |         |         |         |         |
TRBAK3      |         |         |         |         |         |
TRED3       |         |         |         |         |         |
TRIANG      |         |         |         |         |         |
UNIFRM      |**************************************         |
USRDST      |         |         |         |         |         |
VIF         |         |         |         |         |         |
WRTCRD      |*******************************************    |
WRTPAR      |         |         |         |         |         |
XERABT      |         |         |         |         |         |
XERCTL      |         |         |         |         |         |
XERPRT      |         |         |         |         |         |
XERROR      |         |         |         |         |         |
XERRWV      |         |         |         |         |         |
XERSAV      |         |         |         |         |         |
XGETUA      |         |         |         |         |         |
             ----+----|----+----|----+----|----+----|----+----|
```

coverage = 0.	BETA	BETAFN	BETAIC	BETALN	CHKSTR
	CHKTRI	CHLSKY	CMCRD	COROUT	DATOUT
	DMFSD	DSINV	ERRCHK	ERRGET	ERRPRT
	ERSTGT	ERXSET	FDUMP	FINDIT	FINVER
	HISTO	HSTOUT	HYPGEO	I1MACH	IMTQL2
	J4SAVE	MATINV	ONECHK	OUTCRD	OUTDAT
	PMTRX	POSDEF	PYTHAG	R1MACH	S88FMT
	SIFT	SSPEV	TQLRAT	TRBAK3	TRED3
	TRIANG	USRDST	VIF	WRTPAR	XERABT
	XERCTL	XERPRT	XERROR	XERRWV	XERSAV
	XGETUA				
0.40 <= coverage < 0.60	LHS	BANNER	CHKDAT	CHKDIM	CHKZRO
	MIX	RANKER			
0.60 <= coverage < 0.80	DATSQZ	FINVNO	RDPAR	UNIFRM	
0.85 <= coverage < 0.90	RAN	RIERFC	WRTCRD		
0.90 <= coverage < 0.95	NORMAL				
0.95 <= coverage < 1.00	CORCAL				
coverage = 1.00	CONSTA	HPSRT	SETDEF		

Program coverage for this run =0.18

10. Complexity Analysis

Some key metrics are the number of executable statements (sloc), the number of non-blank comments (ncomt), McCabe's extended cyclomatic complexity (vg2), the number of branching statements (cgoto, ugoto, bIF, and lIF), and Halstead's predicted number of errors in (re)writing the code (bhat). Measures are normalized per 100 executable statements for ease of comparison and are listed in the table below.

The branching measures for this code indicate few unconditional GO TO statements and logical IFs for most program modules. This code appears to be fairly well structured.

Most routines have a good ratio of non-blank comments to source code.

McCabe's extended cyclomatic complexity (vg2), normalized per 100 lines of source code, indicates high values. Generally, the routines with the highest complexity are those most likely to have defects. As a guideline, normalized measures of 15 or greater should be considered complex. A software maintenance program should focus on those routines with the highest measures.

Complexity Report by Subprogram for LHS

Name	loc	sloc	cmnt	ncomt	ncomt /sloc	vg2 /sloc	cgoto	cgoto /sloc	ugoto	ugoto /sloc	bIF	bif /sloc	lIF	lif /sloc	Bhat
LHS	353	156	203	162	103.8	26.3	0	0.0	10	6.4	8	5.1	7	4.5	2
BANNER	59	15	29	21	140.0	46.7	0	0.0	0	0.0	0	0.0	6	40.0	0
BETA	49	19	26	20	105.3	21.1	0	0.0	0	0.0	0	0.0	2	10.5	0
BETAFN	11	10	3	2	20.0	30.0	0	0.0	0	0.0	0	0.0	2	20.0	0
BETAIC	522	405	121	63	15.6	19.8	0	0.0	67	16.5	0	0.0	47	11.6	3
BETALN	198	143	54	30	21.0	13.3	0	0.0	28	19.6	0	0.0	10	7.0	2
CHKDAT	31	16	4	3	18.8	56.3	0	0.0	0	0.0	1	6.3	0	0.0	0
CHKDIM	67	23	25	19	82.6	30.4	0	0.0	1	4.3	3	13.0	2	8.7	0
CHKSTR	76	28	22	16	57.1	28.6	0	0.0	0	0.0	2	7.1	0	0.0	0
CHKTRI	13	8	4	3	37.5	50.0	0	0.0	0	0.0	1	12.5	0	0.0	0
CHKZRO	31	12	11	9	75.0	33.3	0	0.0	0	0.0	1	8.3	0	0.0	0
CHLSKY	53	24	24	18	75.0	29.2	0	0.0	2	8.3	0	0.0	1	4.2	0
CMCRD	92	54	27	20	37.0	33.3	0	0.0	0	0.0	3	5.6	2	3.7	1
CONSTA	46	5	33	27	540.0	20.0	0	0.0	0	0.0	0	0.0	0	0.0	0
CORCAL	80	38	37	25	65.8	39.5	0	0.0	0	0.0	1	2.6	0	0.0	1
COROUT	52	22	27	21	95.5	40.9	0	0.0	0	0.0	0	0.0	2	9.1	0
DATOUT	45	14	27	21	150.0	28.6	0	0.0	0	0.0	0	0.0	0	0.0	0
DATSQZ	56	47	6	5	10.6	25.5	0	0.0	5	10.6	4	8.5	4	8.5	0
DMFSD	51	33	17	11	33.3	24.2	0	0.0	4	12.1	0	0.0	3	9.1	0
DSINV	57	42	16	12	28.6	21.4	0	0.0	1	2.4	0	0.0	2	4.8	0
ERRCHK	76	22	54	43	195.5	40.9	0	0.0	0	0.0	0	0.0	8	36.4	0
ERRGET	16	3	16	12	400.0	33.3	0	0.0	0	0.0	0	0.0	0	0.0	0
ERRPRT	20	5	16	11	220.0	20.0	0	0.0	0	0.0	0	0.0	0	0.0	0
ERSTGT	17	10	13	9	90.0	50.0	0	0.0	0	0.0	0	0.0	4	40.0	0
ERXSET	39	3	39	30	1000.0	33.3	0	0.0	0	0.0	0	0.0	0	0.0	0
FDUMP	28	2	29	26	1300.0	50.0	0	0.0	0	0.0	0	0.0	0	0.0	0
FINDIT	65	35	26	20	57.1	42.9	0	0.0	0	0.0	1	2.9	2	5.7	0
FINVER	167	96	83	54	56.3	26.0	0	0.0	19	19.8	0	0.0	11	11.5	1
FINVNOR	12	11	3	2	18.2	18.2	0	0.0	1	9.1	0	0.0	0	0.0	0
HISTO	119	80	30	23	28.8	17.5	0	0.0	12	15.0	0	0.0	6	7.5	1
HPSRT	59	32	29	22	68.8	18.8	0	0.0	5	15.6	0	0.0	4	12.5	0
HSTOUT	58	13	31	24	184.6	23.1	0	0.0	0	0.0	0	0.0	0	0.0	0
HYPGEO	26	21	9	6	28.6	19.0	0	0.0	1	4.8	0	0.0	2	9.5	0
I1MACH	427	8	404	346	4325.0	37.5	0	0.0	1	12.5	0	0.0	1	12.5	0
IMTQL2	171	86	92	64	74.4	19.8	0	0.0	11	12.8	0	0.0	8	9.3	2
J4SAVE	58	5	51	47	940.0	40.0	0	0.0	0	0.0	0	0.0	1	20.0	0

Name	loc	sloc	cmnt	ncomt	ncomt /sloc	vg2 /sloc	cgoto	cgoto /sloc	ugoto	ugoto /sloc	bIF	bif /sloc	lIF	lif /sloc	Bhat
MATINV	45	18	26	20	111.1	27.8	0	0.0	2	11.1	0	0.0	2	11.1	0
MIX	169	97	70	49	50.5	35.1	0	0.0	8	8.2	0	0.0	6	6.2	1
NORMAL	57	26	33	25	96.2	30.8	0	0.0	0	0.0	1	3.8	5	19.2	0
ONECHK	34	12	24	17	141.7	41.7	0	0.0	0	0.0	0	0.0	3	25.0	0
OUTCRD	60	27	24	18	66.7	22.2	0	0.0	5	18.5	1	3.7	2	7.4	0
OUTDAT	153	106	26	20	18.9	23.6	0	0.0	6	5.7	16	15.1	4	3.8	1
PMTRX	101	72	25	19	26.4	29.2	0	0.0	12	16.7	0	0.0	17	23.6	1
POSDEF	65	21	31	19	90.5	14.3	0	0.0	1	4.8	1	4.8	1	4.8	0
PYTHAG	24	16	11	9	56.3	18.8	0	0.0	3	18.8	0	0.0	2	12.5	0
R1MACH	196	5	175	132	2640.0	60.0	0	0.0	0	0.0	0	0.0	1	20.0	0
RAN	29	24	3	2	8.3	25.0	0	0.0	0	0.0	1	4.2	1	4.2	1
RANKER	80	48	37	26	54.2	22.9	0	0.0	9	18.8	0	0.0	6	12.5	0
RDPAR	249	120	78	64	53.3	22.5	0	0.0	19	15.8	4	3.3	1	0.8	2
RIERFC1	115	31	63	34	109.7	22.6	0	0.0	5	16.1	0	0.0	4	12.9	0
S88FMT	36	10	25	22	220.0	20.0	0	0.0	1	10.0	0	0.0	1	10.0	0
SETDEF	51	18	27	21	116.7	16.7	0	0.0	0	0.0	0	0.0	0	0.0	0
SIFT	19	17	4	3	17.6	29.4	0	0.0	0	0.0	0	0.0	0	0.0	0
SSPEV	118	30	96	74	246.7	33.3	0	0.0	1	3.3	0	0.0	7	23.3	0
TQLRAT	148	83	77	53	63.9	25.3	0	0.0	13	15.7	0	0.0	14	16.9	1
TRBAK3	94	28	69	47	167.9	28.6	0	0.0	3	10.7	0	0.0	3	10.7	0
TRED3	126	59	70	48	81.4	20.3	0	0.0	4	6.8	0	0.0	4	6.8	1
TRIANG	48	20	27	21	105.0	25.0	0	0.0	0	0.0	1	5.0	2	10.0	0
UNIFRM	64	37	24	19	51.4	37.8	0	0.0	1	2.7	4	10.8	3	8.1	0
USRDST	160	44	118	70	159.1	38.6	0	0.0	1	2.3	0	0.0	7	15.9	1
VIF	41	11	25	19	172.7	27.3	0	0.0	0	0.0	0	0.0	1	9.1	0
WRTCRD	45	16	26	19	118.8	18.8	0	0.0	2	12.5	0	0.0	2	12.5	0
WRTPAR	104	39	40	32	82.1	23.1	0	0.0	5	12.8	1	2.6	0	0.0	1
XERABT	33	2	33	29	1450.0	50.0	0	0.0	0	0.0	0	0.0	0	0.0	0
XERCTL	47	2	48	43	2150.0	50.0	0	0.0	0	0.0	0	0.0	0	0.0	0
XERPRT	71	42	29	27	64.3	21.4	0	0.0	3	7.1	0	0.0	6	14.3	0
XERROR	52	3	51	46	1533.3	33.3	0	0.0	0	0.0	0	0.0	0	0.0	0
XERRWV	143	83	71	66	79.5	50.6	0	0.0	6	7.2	0	0.0	24	28.9	1
XERSAV	117	56	50	46	82.1	26.8	0	0.0	7	12.5	0	0.0	10	17.9	1
XGETUA	46	9	36	33	366.7	33.3	0	0.0	0	0.0	0	0.0	1	11.1	0

Legend of Metrics in Report

loc -- lines of code
sloc -- number of executable statements
cmnt -- total number of commnts
ncomt -- number of non-blank COMMENT statements
100*ncomt/sloc -- percent, nonblank comments to number of executable statements
100*vg2/sloc -- percent, extended complexity of number of executable statements
cgoto -- number of COMPUTED GO TO statements
100*cgoto/sloc -- percent, computed GOTO's to number of executable statements
ugoto -- number of UNCONDITIONAL GO TO statements
100*ugoto/sloc -- percent, unconditional GOTO's to number of executable statements
bIF -- number of BLOCK IF statements
100*bif/sloc -- percent, Block IF statements to number of executable statements
lIF -- number of LOGICAL IF statements
100*lif/sloc -- percent, logical IF statements to number of executable statements
Bhat -- Halstead's predicted number of errors in writing code